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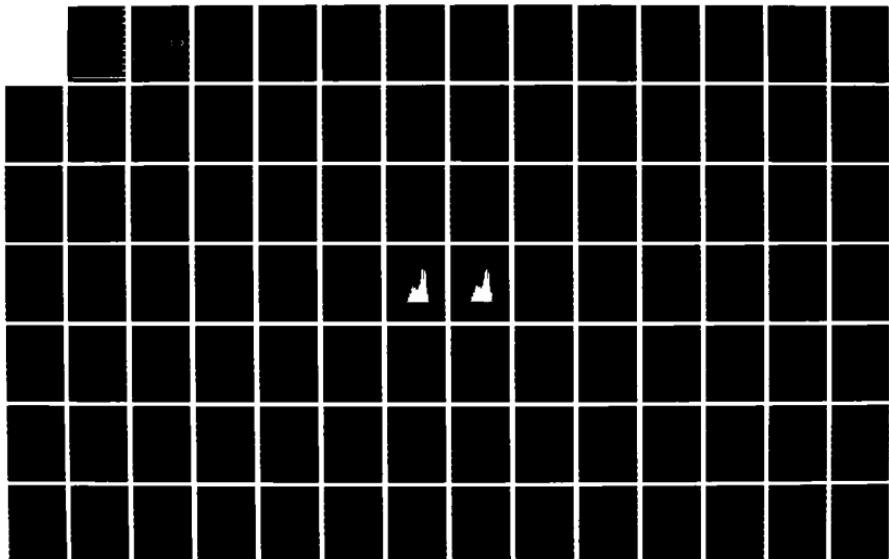
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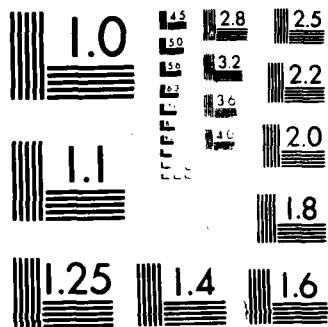
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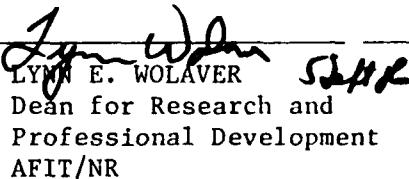
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Abstract  
of  
EFFECTS OF SHIFT WORK ON AIR FORCE SECURITY POLICE PERSONNEL  
by  
Mark Lawrence Goslin

**Statement of the Problem**

US Air Force security police duties involve the potential necessity for making split second life and death decisions which could well affect national security. Since previous studies have clearly documented that shift work has a significant effect on those who perform it, this study examines the perceived effects of shift work on a population of security police personnel.

**Sources of Data**

A comprehensive review of the current literature on the effects of shift work was accomplished. The literature included books, journals, reports, pamphlets, and articles obtained from the following sources: libraries at both the University of Southern California and California State University at Sacramento, the Defense Technical Information Center, the Air Force Office of Security Police, and Strategic Air Command Headquarters. Additionally, a survey to measure the perceived effects of shift work was administered to 187 members of the 320th Security Police Squadron at Mather AFB, California. Finally, a critical analysis of that data was completed.

**Conclusions Reached**

The results of the survey confirmed most of the hypotheses and expectations suggested by the literature. Mather AFB security police night and rotating shift workers reported significantly more work-related sleep problems than their day shift counterparts. Possibly related to the above conclusion, the perceived level of job effectiveness was significantly lower in night shift workers than day shift workers. Many day shift workers, however, reported that late night activities interfered with their job performance. Further, a significant number of night shift workers reported difficulty staying awake on the midnight shift. Clearly, however, the majority of these personnel believed they were more effective working a permanent as compared with a rotating shift schedule. Finally, this group of security police personnel overwhelmingly preferred to work a permanent shift schedule over a rotating shift schedule.

EFFECTS OF SHIFT WORK ON AIR FORCE SECURITY POLICE PERSONNEL

Mark Lawrence Goslin  
B.A., Central Missouri State University

THESIS

Submitted in partial satisfaction of  
the requirements for the degree of

MASTER OF SCIENCE

in

CRIMINAL JUSTICE

at

CALIFORNIA STATE UNIVERSITY, SACRAMENTO

Summer  
1986

EFFECTS OF SHIFT WORK ON AIR FORCE SECURITY POLICE PERSONNEL

A Thesis

by

Mark Lawrence Goslin

Approved by:

James M. Poland, Chair  
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Thomas R. Phelps, Second Reader  
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DATE: 19 May 1986

Name of Student: Mark Lawrence Goslin

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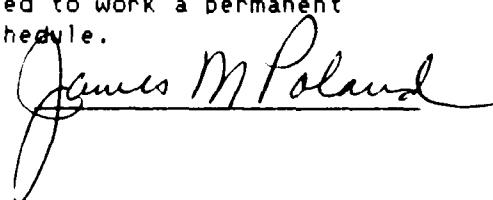
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Committee Chair's Signature of Approval



## Dedication and Acknowledgement

### Dedication

This study is dedicated to the men and women of the United States Air Force security police who maintain vigilance over the country's assets so the nation may sleep safely at night.

### Acknowledgement

The author would like to specifically acknowledge the love and support of his beautiful wife, Robin Sutcliffe. Her patience and understanding helped immeasurably in the completion of this study.

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## CHAPTER 1

### The Problem

#### INTRODUCTION

Society in the United States has developed to the point where many people work other than "normal" shifts in order to provide our citizens with appropriate goods and services. Today, "one in four working men and one in six working women are likely to be on the job at 2 a.m. instead of 2 p.m."<sup>1</sup> As long as 10 years ago, 27% of the U.S. labor force worked a shift which began at a time other than 7-9 a.m.<sup>2</sup> These people include doctors, nurses, policemen, military personnel, shift workers at factories, computer operators, executives of multinational corporations, airline pilots, media writers and broadcasters, newspaper printers, and many others. Researchers are now reporting that significant number of night workers frequently rotate shifts in a way that "violates the natural timing of sleep and wakefulness" and significantly disturbs the lives of individual workers and their families.<sup>3</sup> This study examines this potential problem as it applies to a group of US Air Force security police shift workers.

#### NEED

Currently, there is insufficient research which explores the applicability of biological principles to vigilance intensive careers. The importance of this area of inquiry becomes apparent immediately when it is considered that Air Force security police

personnel perform a variety of critical tasks which potentially require split second life and death decisions that may also affect national security.

To add perspective, it should be noted that the career field is comprised of a large number of individuals who perform a number of vigilance intensive functions at all hours of the day and night. As of 1985 the security police career field employed 1,078 commissioned officers and 39,355 enlisted personnel for a total of 40,433 individuals.<sup>4</sup> A few of the stated missions of this group of professionals include: protection of nuclear and nonnuclear Air Force resources, maintenance of law and order, air base defense, and corrections.<sup>5</sup>

Clearly then, research is needed which would provide security police management with accurate information on the effects of shift work to enable them to manage this large cadre of personnel effectively.

#### PURPOSE

The purpose of this study, then, is to present a detailed synopsis of the current literature pertaining to the effects of shift work on those who perform it and then to supplement that knowledge with the results of a survey of a group of Air Force security police personnel. The survey results should provide information on shift schedule preference, perceptions of performance effectiveness as related to shift schedule, individual adaptability to shift work, and social considerations for the individual worker. The goal of this study, then, is to develop

an initial understanding of the effects of shift work on these personnel in order that management may implement policies to maximize individual effectiveness and minimize risk to individual security policemen and those they are sworn to protect.

#### HYPOTHESES

The survey portion of this study is designed to both provide descriptive information on the effects of shift work and to test several specific hypotheses. The following are several broad research hypotheses which are restated in more specific testable form in Chapter 3 :

1. Security police day and night shift workers have common nonshift-related sleep habits.
2. Security police night shift workers are more negatively affected by shift-related sleep problems than their day shift counterparts.
3. Security police day shift workers feel more effective in performing their duties than their night shift counterparts.
4. Security police shift workers prefer permanent shifts over rotating shifts.

#### TERMS AND DEFINITIONS

To ensure clear understanding of this thesis, terms used throughout the study are defined below.

**Chronobiology.** The general term for all areas of the science that objectively quantifies and investigates mechanisms of biologic time structure, including rhythmic manifestations of life in physiology and behavior.<sup>6</sup>

**Circadian Rhythm.** Self-sustained biological rhythm which in the organism's natural environment is normally entrained to a 24 hour period.<sup>7</sup>

**Cycle.** One successive recurrence of the same sequence of states or events.<sup>8</sup>

**Desynchronization.** Loss of synchronization between two or more rhythms so that they show independent periods.<sup>9</sup>

**Entrainment.** Synchronization of a self-sustaining rhythm by an environmental cycle or another organismic rhythm.<sup>10</sup>

**Period.** Time interval between recurrences of a defined phase of a rhythm.<sup>11</sup>

**Phase.** Instantaneous state of an oscillation within a period.<sup>12</sup>

**Phase shift.** Single displacement along a time axis; may occur instantaneously or after several transient cycles.<sup>13</sup>

**Shift work.** Occupational group performance across natural light-dark cycles.<sup>14</sup>

**Zeitgeber.** An environmental cue which entrains a biological self-sustaining rhythm.<sup>15</sup>

#### OVERVIEW

Chapter 2 of this study contains a comprehensive review of the literature on the effects of shift work. Specifically, the review begins with a discussion of the early perspective and continues with a discussion of human 24 hour cyclical functions, medical problems associated with shift work, studies of human performance efficiency and adjustment to shift schedules, followed by a synopsis of the research into social considerations

and individual differences among shift workers. The literature review ends with a summary of the research efforts which are specifically related to the effects of shift work on individuals who perform police duties.

Chapter 3 contains a full description of the design of the survey portion of this study. Included are discussions on the data collection methodology, the survey instrument, the specific hypotheses to be tested and the descriptive information sought. Finally, this chapter includes a presentation of the specific techniques employed in the analysis of the survey data.

Chapter 4 begins with a presentation of the results of the data analysis, includes a discussion of the results, and ends with a statement of some research conclusions.

Finally, Chapter 5 is comprised of a summary of both the literature review and survey research portions of this study and contains a discussion of implications for future research in this critical area.

## NOTES

<sup>1</sup> Lynne Lamberg, "Circadian Rhythms: Punching Your Body's Time Clock," American Health, Nov. 1984, p. 64.

<sup>2</sup> Donald L. Tasto and Michael J. Colligan, Shift Work Practices in the United States, U.S. Dept. of Health, Education, and Welfare Publication Number 77-148 (Washington D.C.: GPO, 1977), p.3.

<sup>3</sup> Lamberg, p.69.

<sup>4</sup> "An Air Force Almanac: The United States Air Force in Facts and Figures," Air Force Magazine, May 1985, p. 195.

<sup>5</sup> "Air Force Office of Security Police," Air Force Magazine, May 1985, p. 130.

<sup>6</sup> Frederick M. Brown and R. Curtis Graeber, eds., Rhythmic Aspects of Behavior (New Jersey: Lawrence Erlbaum Associates, Inc., 1982), p. 460.

<sup>7</sup> Martin C. Moore-Ede, Frank M. Sulzman, and Charles A. Fuller, The Clocks That Time Us (Cambridge: Harvard University Press, 1982), p. 381.

<sup>8</sup> Brown and Graeber, p. 461.

<sup>9</sup> Moore-Ede, Sulzman, and Fuller, p. 382.

<sup>10</sup> Brown and Graeber, p. 462.

<sup>11</sup> Moore-Ede, Sulzman, and Fuller, p. 383.

<sup>12</sup> Moore-Ede, Sulzman, and Fuller, p. 383.

<sup>13</sup> Moore-Ede, Sulzman, and Fuller, p. 384.

<sup>14</sup> Brown and Graeber, p. 463.

<sup>15</sup> Moore-Ede, Sulzman, and Fuller, p. 384.

## CHAPTER 2

### Review of Literature

#### INTRODUCTION

Evidence is mounting that shift workers' lives are significantly affected by the time of day and the regularity of the shift they work. Additionally, it is apparent that problems may become more significant as the function the worker performs increases in criticality. USAF security police, and police personnel in general, perform tasks and make critical split-second decisions under the influence of the forces of both time of day and shift schedule variations. As stated in Chapter 1, several steps were taken as a part of this research in order to better understand these influences and ultimately provide management with information designed to maximize individual effectiveness. The first step, a review of the current literature on the subject, is presented in this chapter. An effort to add to the current knowledge of the effects of shift work on a security police population will be presented later.

This chapter is divided into several primary areas of discussion. The first of these sections includes a review of the early historical perspective. The second section includes a presentation of human 24 hour cyclical functions and is followed by a discussion of medical problems associated with shift work. The fourth section is devoted to a review of research related to

adjustment to shift schedules. The fifth and sixth sections contain an examination of the social considerations and individual differences in performance of shift work. The seventh section includes a presentation of the police perspective and is followed by a summary of the literature review.

#### EARLY HISTORICAL PERSPECTIVE

The earth, spinning on its axis every 24 hours, submits plants and animals to highly predictable daily rhythms of light and temperature. It is not surprising, then, to find that the behavior and metabolism of most organisms follows a 24 hour schedule. The physiological system responsible for measuring time and synchronizing an organism's internal processes with the daily events within its environment is known as the "circadian timing system".<sup>1</sup> In latin "circa" means approximately and "dies" means days. The word "circadian" was coined by Franz Halberg in 1959 to describe the approximately 24 hour cycles that are internally generated by an organism.<sup>2</sup> The phenomenon of self-sustained, daily biological rhythms, then, is called circadian rhythm.

The rhythmic occurrence of events has not been considered, until relatively recently, as fundamental to living systems.<sup>3</sup> The conceptual advance that stimulated modern scientific activity in this area was the recognition that circadian rhythms are the results of a system which functions to measure time. The Swiss physician August Forel made some chance observations in 1910 when he and his family noticed that, during a terrace breakfast, a few worker bees from a hive located 125 yards from the house arrived

to sample some marmalade on the table.<sup>4</sup> After a few days he found that the bees often appeared on the terrace just before breakfast was served, as if they knew it was time for the food to arrive. Even when the family moved inside for breakfast they noticed that the bees arrived at the appropriate time as though they expected to find food.

This hypothesis, that organisms could truly measure time, was tested by Von Frisch and Beling in 1929. Beling's experiments showed the bees "trained" to feed at a particular time of the day returned at the training time in nearly all situations.<sup>5</sup> Even conducting such experiments 180 yards below the earth's surface in a mine away from natural cues of night and day did not alter the bees' capacity for timekeeping. Beling postulated that the internal circadian timing system thus enables bees to avoid wasting energy in futile visits to flowers which, following a circadian schedule themselves, offer their nectar or pollen only at certain times of the day.<sup>6</sup>

Beginning in the first part of this century, Erwin Bunning laid the foundations for much of our current understanding of the properties of circadian systems.<sup>7</sup> He found that the opening and closing of flowers is often controlled by diurnal light/dark cycles. Bunning discovered that "flowers already begin to open somewhat before dawn, as though they knew the sun was about to rise."<sup>8</sup> He also noticed that if he kept the flowers in the dark, they would still open at the same time and displayed circadian rhythms after they were raised under constant conditions. He went

on to show that these circadian periods were "genetically inherited when strains of plants with different endogenous periods were crossed."<sup>9</sup> Bunning further pointed out the adaptive advantages to organisms of being able to detect seasonal changes in day length. Since that time a large number of investigators have "extensively documented the properties of circadian clocks and demonstrated their generality in organisms ranging from single-celled algae to man."<sup>10</sup>

The nature of rudimentary circadian rhythms in man was first studied by William Ogle who, in 1866, undertook some careful observations of daily body temperature.<sup>11</sup> He found there is a rise in the early morning and a fall in early evening. Erwin Bunning studied the human body temperature rhythm in relation to the light/dark cycle.<sup>12</sup> He found that the body temperature did not invert immediately when the pattern of living had been reversed. This rhythm took more than one week for a complete reversal. Shifting the light/dark cycle and the meal times by twelve hours resulted in a shift of the phase of temperature by only 6 to 10 hours after one week. Usually the inversion was not complete for 9 or 10 days. He also found that the same new setting of phases occurs when a slightly shifted cycle is given, for example a six hour cycle shift in relation to the original. A shift of a few hours may synchronize the physiological rhythm only after several days. Bunning further noted that different functions adjust themselves with varying ease to a phase shifted cycle. Even after some adjustment time, many body functions were

observed to retain the original phase position while others were completely adapted. This dissociation or "desynchrony" must result in physiological disturbances during the transitional period.<sup>13</sup>

In summary, then, the early literature describes scientific observations and studies which characterize the presence of certain biological rhythms which control many functions in both plants and animals. These rhythms were found to be altered eventually by changes in environmental light/dark cycles and were apparently genetically inherited by offspring. More recently, researchers would identify a number of functions in man which are controlled by these circadian rhythms.

#### HUMAN CIRCADIAN FUNCTIONS

Recent research has identified a large number of functions and activities controlled by 24-hour biological rhythms in man. These endogenous (generated from within the organism) rhythms control amplitude, rate, sensitivity, and effectiveness of a number of functions within the human body. Human circadian rhythms are normally synchronized according to external zeitgebers (time cues) such as light-dark cycles, sleep/wake cycles, temperature cycles, food availability, and activity level.<sup>14</sup>

Some of the human functions controlled by circadian rhythms which are identified in the literature include:

Alertness (Vigilance)<sup>15</sup>

Body temperature<sup>16,17</sup>

Blood physiology<sup>18,19</sup>

Blood pressure<sup>20,21</sup>  
Digestion<sup>22,23</sup>  
Galvanic skin response<sup>24</sup>  
Hormone secretion<sup>25</sup>  
Kidney function<sup>26</sup>  
Liver function<sup>27</sup>  
Menstrual cycles<sup>28</sup>  
Performance<sup>29</sup>  
Pulse rate<sup>30,31</sup>  
Respiration<sup>32,33</sup>  
Sensitivity to drugs<sup>34,35,36</sup>  
Sensitivity to pain<sup>37</sup>  
Sleep/wake<sup>38</sup>

Since circadian rhythms enable organisms to master changing conditions within their environment, the individual normally functions in parallel with that environment and is able to react properly to changing conditions. Zeitgebers, then, provide the phase relationship between the "periodicity of the organism and that of the environment."<sup>39</sup> As such, the environment supports the temporal organization of the collective internal rhythms within each individual.

#### MEDICAL PROBLEMS ASSOCIATED WITH SHIFTWORK

Under normal conditions, the circadian period is synchronized with its natural environment, but changes occur as man chooses to alter his way of life. Indeed, shift work requires man to change his eating, working, socializing, and sleeping timetables to a

schedule much different from "normal." The frequent result is conflict between zeitgebers for work-related and social activities. An examination of the research into the physical effects of this change in schedule indicates there are often problems associated with attempts to adopt a new pattern of lifestyle.

Werner Menzel presents a comprehensive review of the early literature on shift work and health related problems.<sup>40</sup> He describes a 1949 study of hospital records of workers conducted by Bjerner, Holm, and Swenson which found a "statistically significant preponderance of intestinal illnesses among shift workers."<sup>41</sup> Similarly, a 1958 study by Graf, Rutenfranz, and Ulich of 600 day shift and 300 night shift workers in Denmark found "night and shift workers in high percentages complain about 'nervous' disorders."<sup>42</sup> Individually mentioned problems were "prolonged fatigued feeling, headache, cold and clammy extremities, irritability, and depressive moodiness."<sup>43</sup> Also described are increased complaints about digestion including changes in appetite, ulcers, and constipation. The report further detailed "in general, the digestive tract problems were more severe in the 'shift-changing' workers ... than" in the day or permanent shift workers.<sup>44</sup>

In 1972, Verhaegen, Maasen, and Meers began a seven year study of a group of 104 male Belgian shift workers employed in a wire mill. Shifts rotated weekly. The employees answered subjective questions designed to measure self described health.<sup>45</sup>

Results indicated there was a "continuous increase in subjective health complaints in neuroticism, in somatic neurotic complaints, in fatigue and digestive symptoms" throughout the period.<sup>46</sup>

Angersbach, and others, reviewed the "sick records" of 270 day workers and 370 shift workers for the period from 1966 to 1977. Their results concluded that significantly more shift workers than day workers with gastrointestinal complaints visited health practitioners, and problems such as gastric ulcer were more severe in shift workers.<sup>47</sup> No differences were detected in terms of cardiovascular diseases.

G. Costa, and others, recently studied 573 male textile workers divided among the day shift, permanent night shift, and weekly rotating shift work. They found a "three to six times higher risk of contracting gastrointestinal disorders and from five to fifteen times higher risk for neurotic troubles" among night workers, both permanent and rotating, as compared to day workers.<sup>48</sup> They also found that incidence of gastroduodenitis, peptic ulcer, and neurotic disorders were significantly higher among rotating shift workers than among any other group.

Conversely, P. J. Taylor studied the sickness absences of male refinery workers over four years. He compared records of day workers with those on weekly rotating shifts and found a "consistent and significantly higher level of sickness absence, lateness, and other absence among day workers" which could "not be wholly attributed to differences in the two populations."<sup>49</sup>

The literature, then, is less than unanimous in its description of the effects of shift work / rotating shift work on those who perform it. The preponderance of the evidence, however, indicates that sleep disorders, fatigue, headaches, moodiness, and digestion problems to include ulcers, changes in appetite and constipation occur more frequently in shift workers. There would also seem to be a virtual concensus that these ailments increase in both incidence and severity in shift workers who rotate among shifts.

Since there is evidence that shift work, and particularly rotating shift work, tends to increase medical problems, it would seem appropriate to investigate how performance is affected.

#### HUMAN PERFORMANCE EFFICIENCY

With increased utilization of 24 hour schedules by both industry and service organizations, researchers have recognized the need to investigate the effects of time of day on worker effectiveness. Optimization of effectiveness levels is, after all, essential to increasing productivity and reducing errors. The earliest efforts to understand these areas involved studying shift and time of day effects on workers within the work environment. More recent research has taken place within the laboratory in an attempt to control for possible contamination of data by extraneous variables.

##### A. FIELD STUDIES

In the earliest study, Browne addressed the speed with which switchboard operators answered calls during a day shift (8 a.m.-4

p.m.), an evening shift (4 p.m.-11 p.m.), and a night shift (11 p.m.-8 a.m.).<sup>50</sup> He found that performance speed improved in a nearly linear manner from 8 a.m. to 6 p.m., and dropped sharply after 10 p.m. "Speed was the slowest for the time span of 1 a.m.-4 a.m."<sup>51</sup>

Bjerner, Holm, and Swenson analyzed time of day logging errors by shift workers reading meters at the Swedish Gas Works.<sup>52</sup> They observed that a steady increase in the number of errors occurred during the 10 p.m.-6 a.m. shift with a maximum error peak occurring at around 3 a.m. Their analysis also identified a post lunch dip when performance decreased between 1 p.m. and 3 p.m.

Hildebrandt, Rohmert, and Rutenfranz studied the reactions of engineers to audio and visual stimuli installed in the cabs of 10 locomotives.<sup>53</sup> Approximately every 20 minutes a warning light appeared for 2.5 seconds. If it was not acknowledged, a warning buzzer would sound for 2.5 seconds. If neither of these signals were heeded, a 30 second horn would sound during which time the engineer had to operate the safety gear to avoid automatic braking. There were 2,238 occurrences of the horn sounding during the period of observation. Despite the fact that the warning light was more visible during the night, more lights were missed during that period indicating a decrease in efficiency. These investigators also documented evidence of a post lunch dip in efficiency and found a peak in the number of horns sounding at about 3 a.m.

Folkard, Monk and Lobban demonstrated reduced hospital safety during the night due to decreased efficiency.<sup>54</sup> They analyzed records of hospital accidents and incidents reported over a 5 year period during which time 1576 reports involving patient accidents included clear indications of time of occurrence. The frequency of accidents was observed to decrease over the normal waking time and to increase over the night. They pointed out, however, that it was unclear whether the increase in accidents was due to circadian variations in the nurses' or the patients' vigilance levels.

Analysis of the results of field experiments, then, provides virtual agreement that human effectiveness in job performance is low during night shifts with minimal efficiency and, conversely, maximal danger from 10 p.m. to 4 a.m. To provide better data to describe performance during unfavorable phases of human performance, researchers have turned to laboratory-based research.

#### B. EXPERIMENTAL STUDIES

Because data tend to differ according to two categories, this description will be divided into studies dealing with perceptual-motor performance and cognitive performance.

##### 1. Perceptual-Motor Performance

Kleitman examined a series of manipulative tasks such as dealing cards, copying texts, transcribing letters and multiplying eight digit numbers.<sup>55</sup> He found that performance tended to improve over the day after waking and was lowest at night. He drew particular attention to a parallelism he found between the

level of body temperature and the level of human performance. J. N. Mills presents an argument for a causal relationship between the two by suggesting that the "brain works better when its temperature is higher, at least over the physiological range."<sup>56</sup> Though others disagree about the evidence for a causal relationship, the parallelism is significant for further study.<sup>57</sup>

Colquhoun studied British Navy radar operators under simulated shift work conditions.<sup>58</sup> He measured accuracy and response time in acknowledging faint audio and video signals as well as body temperature. His data revealed a similar parallelism in detection accuracy and an inverse parallelism in detection speed when compared with body temperature. Data showed an increase in both body temperature and detection accuracy and a decrease in time required for detection throughout the day beginning at approximately 8 a.m. with a significant decrease in both body temperature and performance beginning at 9 p.m. falling to a low at 3 a.m.

Blake evaluated performance of eight tasks throughout the day.<sup>59</sup> Except for signal detection rate all measures were for speed, not accuracy. His results were similar to both the field experiments described earlier and Colquhoun's findings, above. Blake found a rise each morning until noon, then a post lunch dip, followed by a recovery and increase in performance to a maximum level at about 9 p.m. which was his last measurement.

A 1984 study by Craig and Condon tested 48 subjects (34 female, 14 male, median age 19 years) on a battery of six

predominantly perceptual tasks relevant to bridge operations on a ship at sea.<sup>60</sup> During an extended waking day between 8 a.m. and midnight, subjects were tested six times. These researchers found significant time of day effects occurred for alertness, temperature, and pulse rate similar to those described above. They concluded that during those times when arousal was low, performance of some tasks were below the expected norm and suggested that naval vessels may be particularly vulnerable at those times.

Pternitis studied vigilance ratings of 10 power plant operators in three power plants to determine the effects of circadian variation.<sup>61</sup> He measured fatigue according to self evaluation responses on two questionnaires and measured "vigilance" continuously by recording electroencephalogram telemetry data and applying a spectrum density analysis with subsequent factor analysis. Pternitis concluded that, generally, day shift personnel experienced "hypervigilance" while evening shift personnel experienced near normal vigilance but night shift workers evoked a decreased state of vigilance.

Freivalds, Chaffin, and Langolf studied elbow flexion strength, physiological tremor, simple reaction time, maximum information processing rate, and critical eye-hand tracking capacity. Their purpose was "to detect and quantify over a 25 hour period specific variations in human capability, especially those related to job performance."<sup>62</sup> To accomplish this, three male subjects in their twenties were tested for 25 hours on five

separate occasions. They found that circadian variations occur in each area studied though none more than 11% and most of the mean values were around 5%. These researchers suggest their results "indicate important considerations for industry with respect to the problems of shiftwork."<sup>63</sup> They further point out the importance of educating shift workers about the potential for reduced alertness and resultant higher accident potential during poor performance periods.

## 2. Cognitive Performance

The results of time of day laboratory studies relating to memory and employment of more complex thought processes appear to be slightly different from those identified in the area of perceptual-motor performance. Folkard and Monk indicate in a 1980 report that "those tasks which are cognitively more complex, especially requiring verbal reasoning and/or short term memory tend to peak during the late morning or midday."<sup>64</sup> Later, in 1983, Monk (and others) studied a 22 year old male who lived for 52 days in a temporal isolation center away from all normal time cues and found what they described as a split between the circadian temperature rhythm and the sleep/wake cycle.<sup>65</sup> They administered 155 performance tests including manual dexterity and verbal reasoning tasks. Manual dexterity results showed peak performance at nearly the same time as the highest body temperature, whereas verbal reasoning was best soon after awaking.

In another 1983 study, Folkard, Wever, and Wildaruber isolated seven subjects from all natural time cues for 28 days.<sup>66</sup>

Three subjects were given artificial time cues progressively shortened to a 22 hour cycle and four subjects were given time cues which were progressively lengthened to a 29 hour cycle. Upon signal during each "day" each subject completed a simple letter cancellation test and a complex verbal reasoning test. The researchers concluded that "simple, nonmemory-loaded, performance is controlled by the oscillator responsible for body temperature, while more taxing, memory-loaded, performance is controlled by a 21-h oscillator."<sup>67</sup> They further suggest that their findings may have important implications for people who perform shift work which includes mentally taxing, memory-loaded tasks.

#### ADJUSTMENT TO SHIFT SCHEDULES

Earlier discussion documented the facts that a growing percentage of the U.S. population works shifts and that certain circadian rhythms tend to affect personal physical well being and job effectiveness. Further investigation, then, is necessary for the manager who is interested in properly utilizing his personnel within the work environment to maximize effectiveness and minimize accidents and errors. A review of the literature which pertains to the ability of the shift worker to bring about the necessary phase adjustment most rapidly and accurately will be presented in the following section. Shift work systems discussed are the basic types: rotating nonpermanent shifts and fixed permanent systems.<sup>68</sup>

Colquhoun expanded his study of British Navy radar operators (discussed above) when he placed those personnel on 10 p.m.-6 a.m.

shifts for 12 consecutive days to test their adjustment to the schedule.<sup>69</sup> Again, he monitored body temperature and tested accuracy and speed in detecting audio and video signals. He found that by the sixth day the body temperature circadian rhythm had shifted to decrease less during the new working period and had flattened somewhat. During the last six days the temperature rhythm had adapted to where it increased during the work shift though, again, it exhibited somewhat less amplitude as compared to the starting rhythm. Interestingly, Colquhoun found that detection efficiency and accuracy continued to parallel the body temperature. Thus, both efficiency and accuracy of detecting radar signals increased during the duty period as the body temperature rhythm adjusted to the new work schedule. It should be noted that though the workers were not given a "weekend" break which could have added confusing time cues, the body temperature rhythms had not completely inverted at the end of 12 days. Ultimately, Colquhoun states that "weekends" are relevant in considering comparative advantages of shift systems in that there is significant social pressure on the worker to revert to a "normal" mode of living at that time. He concludes that permanent shifts are "not the solution (at least from our point of view) because the temperature rhythm presumably also reverts back to normal on these days off, and then has to start adapting all over again when work is resumed."<sup>70</sup>

In a 1978 paper, Knauth (and others) studied the circadian temperature rhythm of six subjects who worked 3 weeks on a

permanent night shift without "weekend" breaks.<sup>71</sup> They compared the time of peak temperature for the workers on their last day shift with that on the last night shift and found an average time shift of just over 8 hours. An overall change in the wave form of body temperature was suggested by their frequency analysis. Also, a larger circadian amplitude was related to slower adjustment of the phase of body temperature. Interestingly, the factor which was observed to most influence the adjustment of the phase was time of sleep rather than time of work.

Martin C. Moore-Ede advises that the best shift arrangement is for each individual to be permanently assigned to a shift so "they have ample time to readjust and be at their best during the working period each day."<sup>72</sup> He continues to explain that the problems with this optimum schedule are that few people want to work permanent night shifts and those who do often revert to a daytime schedule during vacations and some weekends. Consequently, he worked with Charles A. Czeisler and Richard M. Coleman on a study designed to optimize a rotating shift system.<sup>73</sup> They focused on the two issues of direction of rotation and interval between shifts to increase worker satisfaction and productivity where permanent shifts were impractical. They also compared 85 male rotating shift workers with 68 male nonrotating day workers and found that a forward rotation between shifts every 21 days best achieved their objectives.

Folkard, Monk, and Lobban examined full-time and part-time female nurses who typically worked a 8:45 p.m.-7:45 a.m. shift as

part of their study presented earlier.<sup>74</sup> "Full-time" nurses who had prolonged experience on nights worked four nights on and three off while "part-time" nurses worked two nights and were off for five days. One purpose was to determine if any "long-term" adjustment to night shifts occurred with extended night shift experience. Body temperature and subjective self-ratings of alertness and well being were recorded. The results indicated there was a reduction in the usual decreases in body temperature and self-ratings of alertness and well being in permanent night nurses. Also, the long-term adjustment of temperature did not exhibit the flattening of the circadian rhythm (as described by Colquhoun, above) during days off. The researchers concluded that the factor which contributed most to long-term adjustment was the full-time nurses' commitment to night work. In other words, whereas the part-time nurses were found to schedule their activities to a predominantly day-oriented pattern, the full-time night nurses were committed to a nocturnal way of life.

Variable memory loads were studied by Folkard, Knauth, Monk, and Rutenfranz in 1976. Two subjects on an experimental rapidly rotating (2-2-2) shift system performed low (2 target), medium (4 target), and high (6 target) memory load versions of the "Memory and Search Task" every 2 hours and 40 minutes while working.<sup>75</sup> The research reports little disruption in the circadian rhythm for body temperature which was measured throughout the 6-day cycle and presents interesting results when performance on the three tests are compared with temperature. A graph of 2 target (low memory

load) test performance was nearly identical to that of body temperature. The 4 target test results revealed no correlation with the temperature curve and, most interestingly, the 6 target (high memory load) performance proved inversely correlated with body temperature so that high memory load performance was highest when body temperature was lowest and vice versa. As reported above (Cognitive Performance), Folkard believes these results support the conclusion that there is not a single circadian rhythm which controls performance efficiency.

In his 1980 discussion, Folkard presents his conclusions on shift systems. He advises there "is no single 'optimal' shift system for ensuring adequate levels of productivity and safety."<sup>76</sup> He stated that the demands of the task and the type of shift system interact with each other via the worker's circadian rhythms in determining performance. Finally, he states "there clearly are situations where high levels of performance efficiency and safety have to be maintained on the night shift. If all other factors are equal, the results reviewed in this paper favour 'permanent' systems for simple perceptual-motor tasks but rapidly rotating ones for more cognitive, memory loaded tasks."<sup>77</sup>

#### SOCIAL CONSIDERATIONS

Besides the physical and psychological results of shiftwork on the individual, there is strong evidence that shift work also affects the family and social environment of the worker. This should not be surprising as each individual is a social being whose responsibilities to family and friends must be adjusted to fit the work schedule.

Paul Mott and his associates studied workers at five plants to determine the effects of shift work on their family and social lives.<sup>78</sup> They focused on the conflict that shift workers experience in carrying out their roles as fathers, mothers, husbands, wives, friends, and members of the community. Mott found that the amount of difficulty reported among shift workers in fulfilling the activities of their various role requirements was related to the degree to which there was a conflict between the time that an activity usually occurs and the duty schedule. Thus an evening shift worker "generally reported the greatest amount of difficulty in those role behaviors associated with early evening" such as spending time with school-age children and helping the wife with household duties.<sup>79</sup> On the other hand, night shift workers had much more difficulty with roles normally associated with late night hours such as sexual relations and protecting the wife and family from harm.

When Alexander Wedderburn interviewed 315 rotating shift workers in the British steel industry he found their single largest complaint involved the effects of shift work on their social lives.<sup>80</sup> Fully 61% complained of social problems as their primary objection to their work schedule.<sup>81</sup> Shift workers also related they were significantly worse off than their day time counterparts in terms of weekends (77%), a full social life (69%), watching sports (66%), attending social functions (61%), and following a regular TV series (51%).<sup>82</sup>

Gannon, Norland and Robeson explain that social alienation frequently causes groups of workers to cling together and form an occupational community among themselves.<sup>83</sup> Thus a group of shift workers may form a softball or bowling team in order to satisfy social needs which could not be scheduled with the "normal" world. Wives and children often form similar informal support groups with the same goals in mind.

Jane Hood and Nancy Milazzo found that when social stress is added there is an increasing probability the worker will suffer from physical stress symptoms. Their study of 85 nurses indicated "even though shiftwork need not interfere with family role performance, when it does, physiological symptoms are a likely response."<sup>84</sup> They also relate that physical symptoms are frequently more severe in single people because marriage often functions as a buffer for the effects of environmental stress. Finally, they state that family members also experience stress because they cannot understand why the worker is always tired and is seldom available to share important occasions.

Clearly, then, a worker's social life is frequently affected by a requirement to work night or rotating shift work. It appears that the intensity of the results is related to the level of conflict between the schedule and the worker's needs and goals. Consequently, a young mother or father who values highly their contribution to spouse and children will probably experience a significant amount of stress. This stress may result in behavior which aggravates the family relationship and may also translate

into physical symptoms. The family-oriented person who has problems physically adjusting to shift work, then, will have a tremendous difficulty with a night or rotating shift schedule. Therefore, management would benefit from a means of identifying individuals who are least adaptable.

#### INDIVIDUAL DIFFERENCES

There is a growing body of evidence which indicates there are significant differences in the levels and ease with which individuals tolerate shift work. A brief discussion of some of the data may be helpful in providing an understanding of possible paths for future study.

Akerstedt and Froberg point out the importance of amplitude and stability of each individual's circadian rhythms. They describe the results of Kleitman's 1939 study which distinguished between "morning types" (M-types) and "evening types" (E-types) on the basis of phase differences in the body temperature rhythm and found similar differences in perceptual-motor performance.<sup>85</sup> They advise they have collected empirical support for the concept that "M-types have shorter circadian periods than E-types, (and are) thus better adapted to our normal 24 hour period."<sup>86</sup> They also relate, however, that M-types tend to have difficulties adapting their circadian rhythms and make up a disproportionately large number of transferees from shift work. Conversely, E-types who have circadian periods longer than 24 hours, constantly adapt and are more functional in a shift work environment. Thus,

identification of chronotype may have some value in predicting if an individual is more suitable for shift work than others.

Since the above review, studies have been reported which suggest it may be feasible to predict adjustment to night work from questionnaire results. Brighthaupt (and others) reported relationships between scores on a morningness questionnaire and characteristics of sleep at unusual times.<sup>87</sup> In a more comprehensive study, Folkard, Monk, and Lobban developed a twenty question pencil and paper test designed to identify shift work adaptable individuals. Answers to questions on rigidity of sleeping habits, ability to overcome drowsiness, and morningness resulted in a number of significant correlations with oral temperature "thus indicating the factors had at least concurrent validity."<sup>88</sup>

It would appear, then, that based upon results of research similar to that described above it may prove possible to accurately select individuals to man shift systems for maximum effectiveness. E-types, whose circadian rhythms adapt most easily, could be selected for critical shift manning to provide maximal output in perceptual-motor tasks.

#### THE POLICE PERSPECTIVE

In light of the above conclusions relating to decreased vigilance, increased potential for error, and the possibilities for family difficulties it is incumbent upon police managers to examine their policies relative to the police patrol function. This section provides a brief discussion of that function and a

preliminary examination of potential problems based upon research findings.

The vast majority of the functions a police patrol officer performs are perceptual-motor in nature.<sup>89</sup> In fact, primary functions may be subdivided into categories of perceptual, motor, and combinations of the two. Within the perceptual category, officers primarily employ watching and listening skills. They may watch for open doors or windows in a business area, for suspicious persons or for speeders. A patrol officer listens for suspicious sounds such as breaking glass or a scream, and must be constantly vigilant for a radio call. Motor functions include driving a car, physically arresting a suspect, running, fighting, or shooting a gun. Frequently the officer is called upon to combine perceptual and motor functions. For example, he may hear breaking glass, see a close-by suspicious subject and the chase the suspect down the street to detain him. While the officer employs basic cognitive tasks such as remembering the appropriate penal code section for a particular violation, he or she is rarely required to perform functions similar to the memory loaded tasks described earlier.

In contrast, the United States Air Force security police career field is divided into two parts. The first is the law enforcement specialty which requires tasks that are identical to those performed by civilian police patrol officers. The second is the security specialty which is responsible for the protection of the nation's critical nuclear and nonnuclear resources. Security specialists also perform similar perceptual-motor tasks related to

vigilance and reaction behaviors since their primary responsibilities include detection and neutralization of individuals or forces intent on damaging or stealing Air Force assets. Since these functions are also critical and no data is available on the effectiveness or vulnerability of Air Force personnel, it is appropriate to continue to investigate statistics which pertain to police patrol officers.

A check of law enforcement statistics reveals that patrol officers are most frequently killed while performing perceptual-motor tasks.<sup>90</sup> Situations include (in descending order of occurrence): robberies in progress or pursuing robbery suspects, attempting other arrests, traffic stops, investigating suspicious persons and circumstances, and family disturbances. Since police patrol duties are primarily perceptual-motor, then, the police manager must be concerned with the danger period between 10 p.m. and 4 a.m. described in the earlier section on human performance efficiency.

Another reason for particular concern for this time period is revealed by further examination of the statistics on police officer murders. The Uniform Crime Report for 1979 contains a table which is reconfigured below as Figure 2.1.<sup>91</sup> This figure begins at the left bar depicting the total number of law enforcement officers killed during the period 1969-1978 between 6 a.m. and 7 a.m. The second bar depicts the 7 a.m.-8 a.m. time period and so on covering the entire 24 hour day. The data reveal a significantly larger number of police officers are killed

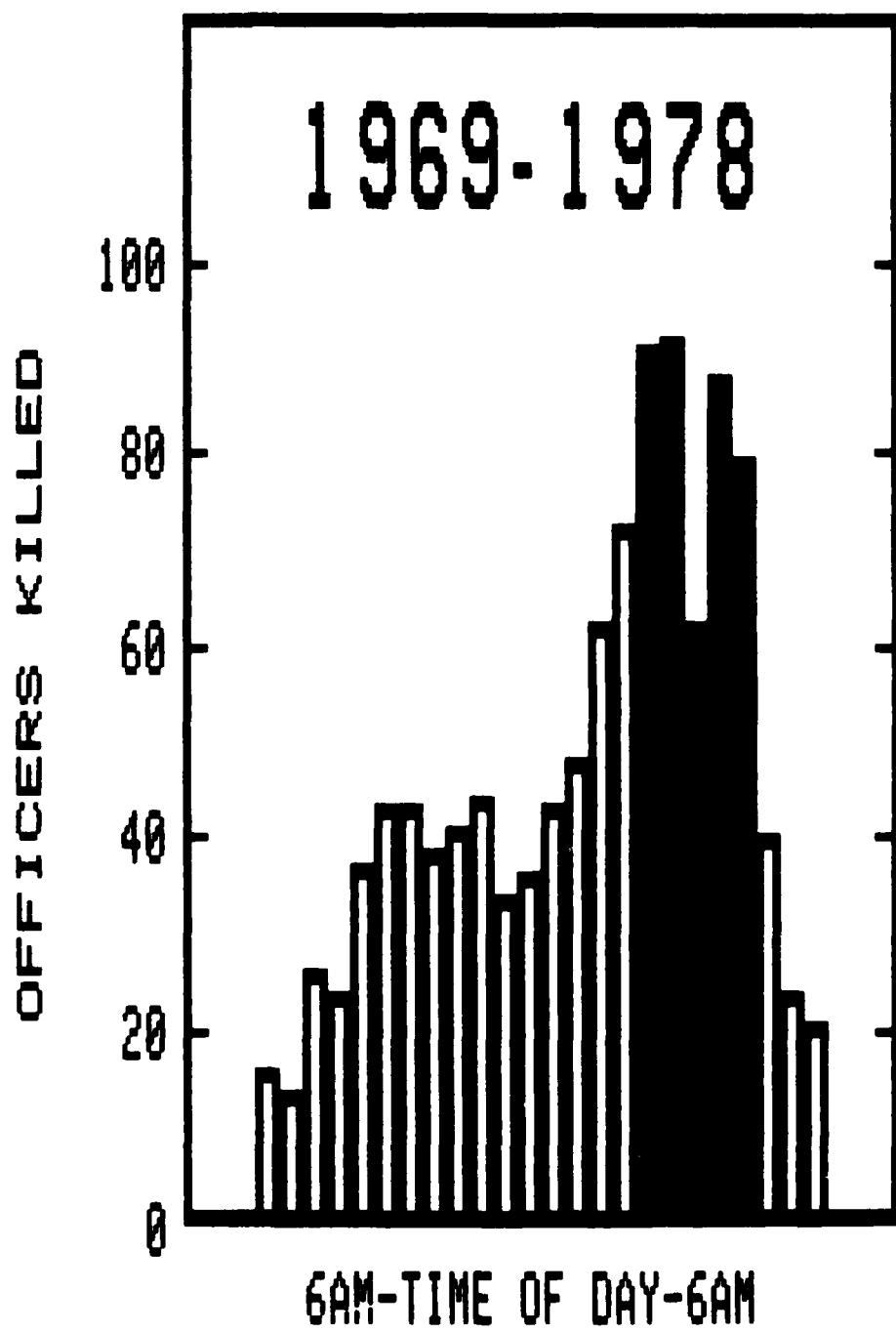


Figure 2.1

Law Enforcement Officers Killed 1969-78, By Time of Day

Source: 1979 Uniform Crime Reports

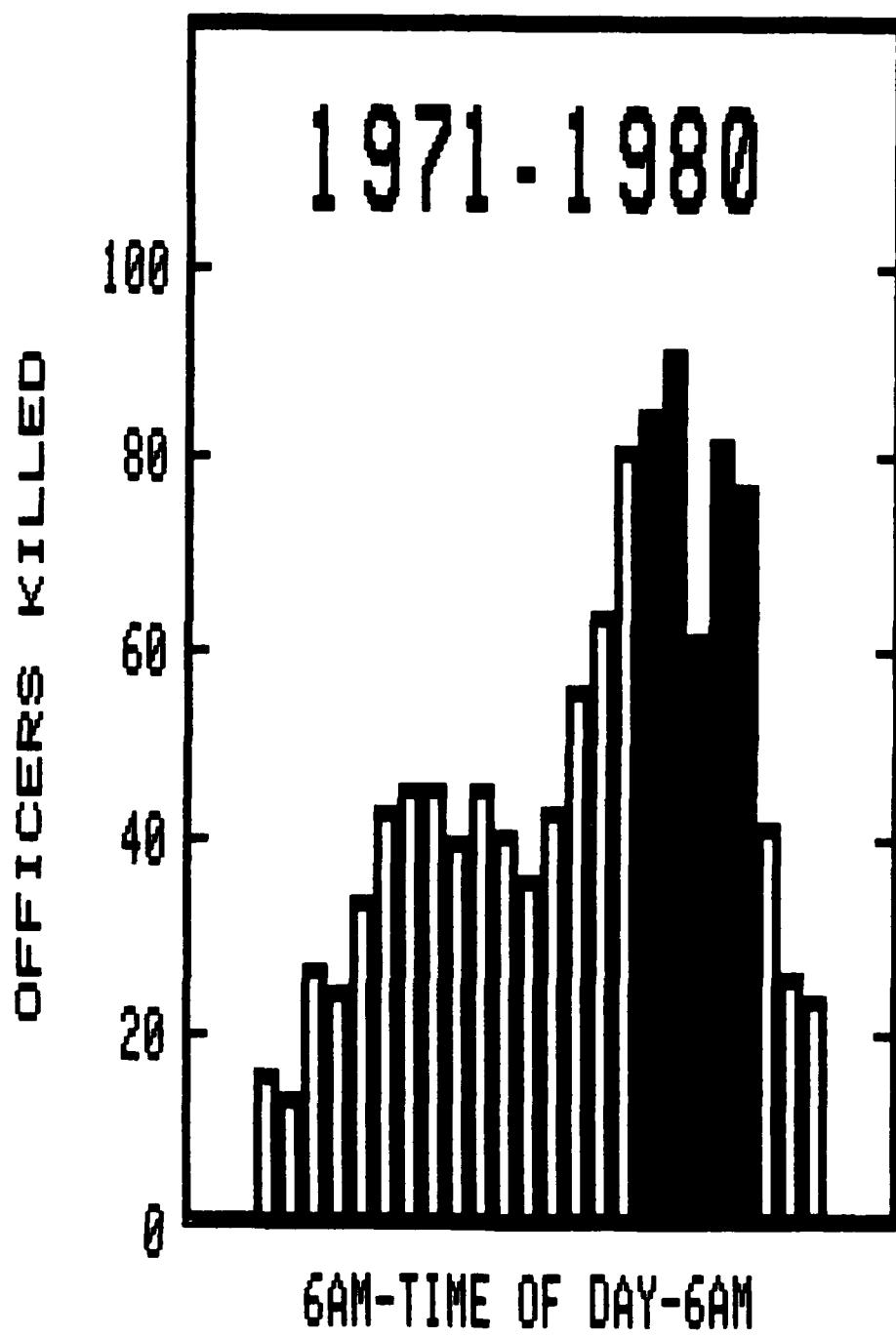


Figure 2.2

Law Enforcement Officers Killed 1971-80, By Time of Day

Source: U.S. Dept of Justice

between 10 p.m. and 3 a.m. (blackened area). Figure 2.2 depicts the period 1971 through 1980 and shows a nearly identical trend.<sup>92</sup> Police officer murder data, then, in combination with information discovered about time of day vulnerabilities should motivate the police manager to investigate thoroughly the results of shift work (particularly rotating shift work) on the perceptual-motor effectiveness of his officers.

A review of the recent literature related to police shift schedule management reveals a sparsity of discussion on the subject. Buren and Stenzel discuss what they describe as employment of effective scheduling to reduce sick leave and overtime, permit efficient use of equipment, allow more leisure time, and enhance recruitment.<sup>93,94</sup> Their presentations, however, are less than specific and contain few recommendations for managers. Similarly, results of employment of alternative schedules such as the 10-hour day<sup>95</sup> and the 12-hour day<sup>96</sup> indicate only mixed success.

Two studies were initiated because of a desire to reduce the negative effects of circadian rhythms due to rotating shift work. In the first, a very small police department with 26 patrol officers replaced their rotating shift system with a permanent shift system. "The municipality and the patrolman's association both reasoned that if an individual were working a shift that was compatible to that person's metabolism, it would follow that that (sic) individual would function better, feel better, become less run down and, therefore, use less sick time."<sup>97</sup> After a year the

department compared sick leave data for the permanent shift schedule with that of the last year of rotating shifts and administered a questionnaire. The results were again mixed in that officers stated they felt better physically and believed they were more effective on the permanent shift schedule but actually took more sick leave. The increase in the use of sick leave was explained by questionnaire responses which indicated more time was taken for nonillness related recreation. A second, more comprehensive, study was recently initiated in the city of Queens, N.Y.<sup>98</sup> A precinct with 158 officers was placed on permanent shifts in order to test the effects on physical and emotional stress as well as family and social activities outside of work. This study is not yet completed but the results should be available later in 1986.

#### SUMMARY

The early literature describes scientific observations and studies which characterize the presence of certain biological rhythms which control many functions in both plants and animals. These rhythms, later named "circadian rhythms" were found to be altered eventually by changes in environmental light/dark cycles and were apparently genetically inherited by offspring.

More recently, researchers identified a number of functions in man which are affected by these circadian rhythms, including: alertness, body temperature, blood physiology, blood pressure, digestion, galvanic skin response, hormone secretion, kidney function, liver function, menstrual cycles, performance, pulse

rate, respiration, sensitivity to drugs, sensitivity to pain, sleep/wake cycles. Further investigation revealed that shift work frequently required changes in eating, working, socializing, and sleeping timetables and that these changes tend to desynchronize circadian control. The preponderance of the evidence indicates that sleep disorders, fatigue, headaches, moodiness, and digestion problems to include ulcers, changes in appetite and constipation occur more frequently in shift workers. There is, in fact, a virtual concensus that these ailments increase in both incidence and severity in shift workers who rotate among shifts. (See also Table 2.1 for a summary of research presented in this chapter.)

Because of the apparent decrease in physiological efficiency in shift workers, a review of the literature pertaining to human performance efficiency was undertaken. Field experiments provide virtual agreement that human effectiveness in job performance is low during night shifts with minimal efficiency and, conversely, maximum danger of errors between 10 p.m. and 3 a.m. The results of experimental studies tend to differ according to two catagories: perceptual-motor performance and cognitive performance. Experiments which measure the speed and accuracy of response to simple audio and visual stimuli (perceptual-motor) indicate that effectiveness increases throughout the morning, experiences a slight "post-lunch dip", followed by a recovery and increase to a maximum level at approximately 9 p.m. Performance typically begins to decrease at that time, falling to a low at approximately 3 a.m. Significantly, it was also found that

individual circadian rhythms tend to shift as a worker changes his work-sleep cycle. This conclusion lends support to the idea that adaptation can effectively occur in individuals who work the same shift "permanently". Cognitive performance tests produced slightly different results in that the more complex tasks which required significant verbal reasoning and/or short term memory tend to peak in late morning.

The above results, of course, raise the question of which shift arrangement is best for maximizing worker effectiveness levels. While there is not total agreement among the experts in the field, Dr. Simon Folkard seems to present the majority opinion when he advises that the demands of the task and the type of shift system interact with each other via the worker's circadian rhythms in determining performance. Finally, he states

"there clearly are situations where high levels of performance efficiency and safety have to be maintained on the night shift. If all other factors are equal, the results reviewed in this paper favour 'permanent' systems for simple perceptual-motor tasks but rapidly rotating ones for more cognitive, memory loaded tasks."<sup>99</sup>

Additionally, there is a growing body of evidence which describes significant differences in the levels and ease with which individuals tolerate shift work. Studies based upon "morning type" and "evening type" personalities (chronotypes) conclude that "morning types" tend to have more difficulty adapting their circadian rhythms to rotating shifts. Conversely, "evening types" constantly adapt and are more functional in the shift work environment. These studies support a conclusion that

Identification of chronotype may have some value in predicting if an individual is more suitable for shift work than others.

Social considerations have also been found to affect the individual worker. Clearly, a worker's social life is frequently affected by a requirement to work night or rotating shift work. It appears that the intensity of the results is related to the level of conflict between the schedule and the worker's needs and goals. Consequently, a young mother or father who values highly their contribution to spouse and children will probably experience a significant amount of stress. This stress may result in behavior which aggravates the family relationship and may also translate into physical symptoms. The family-oriented person who has problems physically adjusting to shift work, then, will have a tremendous difficulty with a night or rotating shift schedule. Therefore, management may again benefit from a procedure for identifying individuals who are least adaptable to shift work from a social perspective.

In light of the above conclusions relating to decreased vigilance, increased potential for error, and the potential for family difficulties it is incumbent upon police managers to examine their policies relative to police patrol. The importance of this task becomes even more apparent when it is discovered that the time of day when most officers are killed in the line of duty is also the time of day when the above described studies show they are likely to be least effective. Since patrol officers perform functions which may be classified as almost exclusively

perceptual-motor, the preponderence of the literature supports a decision to employ a permanent or semi-permanent duty schedule. However, there have been few studies which test the individual opinions of effectiveness in personnel who perform police-type functions. The study described in Chapter 3 was designed to explore these perceptions with an emphasis on collecting data to support well-informed management decisions directed toward maximization of security police effectiveness.

Table 2.1  
Summary of Research Cited

Researcher(s)	Studied	Results/conclusions
<b>EARLY EXPLORATORY STUDIES</b>		
Von Frisch Beling	Bees trained to feed at particular time of day in absence of internal time cues	Bees possess an internal circadian timing system
Bunning	Opening/closing of flowers.	A genetically inherited circadian system controls opening/closing
Ogle	Human body temp cycles	A cyclical rise in early morning and a decline in early evening identified
Bunning	Reversal of light/dark cycles	Approx. 9-10 days necessary for temp cycle to adapt to 12 hr change  Other body functions adapt at different rates
<b>WORKER HEALTH STUDIES</b>		
Bjerner, Holm, and Swenson	Health records of day and shift workers	Intestinal illnesses occur more frequently in shift workers
Graf, Rutenfranz, Ulich	Health of day, night, and rotating shift workers	Night shift workers complain of fatigue, headache, irritability  Rotating workers complain more of problems with ulcers and constipation
Verhaegen, Maasen Meers	Health of male rotating shift workers	Complaints of fatigue, sleep and digestion problems

Researcher(s)	Studied	Results/conclusions
Angersbach, and others	Health records of day and shift workers	Shift workers had sig. more gastrointestinal problems
Costa, and others	Health of day, per- manent night, and rotating shift	3-6X higher rate of gas- trointestinal problems and 5-15X higher rate of neurotic (including sleep) problems among both types of night workers
		rotating shift workers had highest rate of gastroin- testinal and neurotic dis- orders
Taylor	"Sickness" absences of day and rotating shift workers	Higher rate of absence and lateness among day workers
<b>PERFORMANCE EFFICIENCY - FIELD STUDIES</b>		
Browne	Speed of answering switchboard calls by day, evening, & night shift oper- ators	Speed (1) increased from 8 a.m. to 6 p.m. (2) drop- ped sharply after 10 p.m. (3) was slowest 1-4 a.m.
Bjerner, Holm, & Swenson	Meter reading errors by time of day	Increase in errors 10 p.m. - 6 a.m. with peak approx. 3 a.m.
Hildebrandt, Romert, & Rutenfranz	Acknowledgement by train engineers of audio and visual stimuli (by time of day)	Increased effectiveness from early a.m. until post lunch dip at approx. 1 p.m., high efficiency until late evening, de- clining to low at approx. 3 a.m.
Folkard, Monk, & Lobban	Hospital safety by time of day	Accident rate decreased over waking day and increased over night

## PERCEPTUAL-MOTOR PERFORMANCE

Researcher(s)	Studied	Results/conclusions
Kleitman	Human performance of simple manipulative tasks throughout day	(1) Performance improved throughout day and was lowest at night  (2) Parallelism between body temperature and performance level
Colquhoun	Accuracy and response time acknowledging audio and visual signals by shift workers	Increase in accuracy and response efficiency as body temp. increased from 8 a.m. to 9 p.m. then a decrease parallel with body temp. to a low at approx. 3 a.m.
Blake	Performance of 8 tasks throughout day	(1) Rise in morning effectiveness until noon (2) Post-lunch dip (3) Recovery and rise until 9 p.m. (4) decreased effectiveness followed
Craig & Condon	Perceptual tasks related to shipboard bridge operations	Similar to 3 studies above
Pternitis	Vigilance of power plant shift workers	(1) Day shift - hypervigilance (2) Evening shift - normal vigilance (3) Night shift -decreased vigilance
Frievalds, Chaffin, & Lanfolf	Reaction time, info processing, eye/hand tracking and elbow flexion strength over 25 hr day	Circadian variation of 5-11% during day

## COGNITIVE PERFORMANCE

Researcher(s)	Studied	Results/conclusions
Folkard & Monk	Simple and complex cognitive tasks by time of day	More complex cognitive tasks (especially those requiring verbal reasoning) peak during late morning
Monk & others	A 22 year old male in temporal isolation	(1) Manual dexterity peaks in parallel with body temp (2) Verbal reasoning peaks soon after waking
Folkard, Wever, & Wildegruber	Temporally isolated subjects performing simple and complex cognitive tasks	(1) Simple (nonmemory loaded) performance is controlled by oscillator responsible for body temp  (2) Memory-loaded performance controlled by separate 21 hr oscillator

## ADJUSTMENT TO SHIFT SCHEDULES

Colquhoun	Accuracy and speed of detection of audio and visual signals after moving workers to a permanent night shift	(1) Performance and detection accuracy increased with body temp which shifted toward a day schedule by the 6th shift  (2) Body temp rhythm had not completely inverted by 12th shift
Knauth & others	Circadian body temp of 6 subjects during 3 weeks of permanent night shifts	Body temp rhythm had adjusted 8 hours
Moore-Ede, Czeisler, &	Productivity and satisfaction in rotating & nonrotating shift workers	A forward rotation between shifts every 21 days best achieved objectives

Researcher(s)	Studied	Results/conclusions
Folkard & Monk	Full and part time nurses assigned to night shift	(1) Permanent night nurses reported increased body temp and higher ratings of alertness  (2) Attributed to commitment to nocturnal way of life
Folkard & others	Performance of low, medium, and high memory load tasks while working rapidly rotating shifts & body temp	(1) low memory load task performance in parallel with body temp (2) Medium memory load tasks showed no correlation with body temp (3) High memory load tasks correlated inversely with body temp (4) Permanent shifts are best for simple perceptual motor tasks, while rotating shifts are best for more cognitive, memory loaded tasks
Mott & others	Effects of shift work on family and social life	Amount of difficulty related to level of conflict between work and social requirements
Wedderburn	Effects of rotating shift work on social life	(1) Primary objection to shift work is negative effect on social life  (2) 77% believe worse off in terms of weekends, 66% in watching sports, 61% in attending social functions

Researcher(s)	Studied	Results/conclusions
Hood &	Nurse shift workers	<p>(1) When shift work interferes with family, physical symptoms are likely</p> <p>(2) Marriage often acts as buffer for stress</p> <p>(3) Family members also experience shift work stress</p>
<hr/> INDIVIDUAL DIFFERENCES		
Akerstedt & Froberg	Morning (M) and Evening (E) type individuals	<p>(1) M types have shorter circadian periods and have difficulty adapting to shift work</p> <p>(2) E types have circadian periods over 24 hrs and constantly adapt</p>
Folkard, Monk & Lobban	Shift work adaptability of individuals	Test scores on rigidity of sleeping habits, ability to overcome drowsiness, and "morningness" correlated with both oral temp and adaptability
<hr/> POLICE STUDIES		
U. S. Dept of Justice	Police officers killed 1969-1978 and 1971-1980	Most police officers are killed between 10 p.m. and 3 a.m.
U. S. Dept of Justice	Police officers killed, by duty performed	Police officers are killed responding to (in order): robberies, attempting arrests, traffic stops, suspicious persons, family disturbances
Graupman	Officer preference for permanent or rotating shifts	Officers felt better and more effective on permanent shift

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## CHAPTER 3

### Design of the Study

#### INTRODUCTION

The short range objective of this research is to gather data which provide information about the specific effects of shift work on US Air Force security specialists. The study is cross-sectional in design in that it measures a phenomenon at a point in time and proceeds to carefully analyze that cross section.<sup>1</sup> The resulting product is primarily descriptive in that general hypotheses are tested in order to describe a situation rather than to explain why the situation occurs.<sup>2</sup> The ultimate purpose of the analysis is to acquire sufficient understanding of the shift work environment to assist managers in their decisions toward increasing effectiveness and job satisfaction in 24 hour police organizations.

#### DATA COLLECTION METHODOLOGY

Babbie advises that "survey research is probably the best method available to the social scientist interested in collecting original data for describing a population too large to observe directly."<sup>3</sup> Consequently, a survey was constructed to measure individual perceptions of a variety of potential effects of night and rotating shift work as compared to permanent day work.

Permission was obtained from both the Strategic Air Command Headquarters (Chief of Security Police) and the 320th Security Police Squadron (Chief of Security Police) to administer the

attached shift work survey<sup>4</sup> (See Appendix A) at the pre-shift meeting called "guardmount." The questionnaire was administered during the last week in May 1985 to all members of the 320th Security Police Squadron at Mather AFB California who work on "flight" performing duties on the day or night shifts. Each flight was individually briefed on the purpose of the project and its implications for shift workers. Survey completion time averaged approximately 15 minutes. Of the 187 total members surveyed, 44 were assigned to a permanent day shift ("A" Flight) and the remainder were assigned to rotating night flights in the following proportions: 46 on "B" Flight, 47 on "C" Flight and 50 on "D" Flight.

Flight duties consist primarily of perceptual-motor tasks related to detecting potential intruders into restricted areas and responding to control the intruder(s). Restricted areas are fenced locations which contain US Air Force alert aircraft and weapons. Entry to restricted areas is tightly controlled by security personnel using strict methods of identification including special security badges and word code identifiers. The areas also contain security personnel who are tasked to respond to any suspicious activity inside or outside of the fenced boundary. Each security flight is composed of a junior officer (usually a Lieutenant) and an all-male contingent of enlisted security specialists.<sup>5</sup>

The squadron at Mather AFB provided a unique opportunity for data collection in that two shift schedules have been employed

within the last year. Until January 1985, the squadron worked a permanent shift schedule composed of three flights each of which worked either a day, swing (evening), or midnight shift consisting of six days (nights) on-duty followed by three days off. In January, the squadron changed to a rotating shift format which also consisted of six days on-duty followed by three days off. The most recent format employs a permanent day flight and three night flights which rotate between three days of swings, three midnight shifts, and three days off. The day shift contains elements which each work six days followed by three days off.

The sampling technique employed might best be described as "purposive or judgemental" in that it is based upon the researcher's "own knowledge of the population."<sup>6</sup> Though this technique was selected primarily for convenience, there is evidence which supports a conclusion that the Mather squadron closely resembles any population of security police personnel who perform shift work at any base. Indeed, each base might be properly viewed as comprising the near-equivalent of a systematic stratified sample. This conclusion is based upon an analysis of the USAF assignment process. The security police career field contains 39,355 enlisted personnel and 1,078 officers assigned to 136 installations with the United States and overseas.<sup>7</sup> Rank and experience requirements are specified within the personnel assignment system for each individual duty position. These specifications act to stratify the individual base requirements for manpower. The personnel computer system for enlisted

personnel makes nearly random assignments of individuals to fill specific positions for those below the rank of Senior Master Sergeant. All flight personnel at the Mather AFB squadron are below that rank. Though officers have a higher degree of effectiveness in influencing their assignments there were only four officers who completed the survey. Therefore, despite the fact that individuals have some input into the assignment process in specifying duty location preference, the result of location selection should be relatively insignificant since there is little reason to believe that preference for a particular geographic location would have a significant effect the worker's susceptibility to negative physical or social effects of shift work. With this discussion in mind, however, it should be noted that there will be no attempt to generalize the results of this study all U. S. Air Force security policemen.

#### THE SURVEY

The survey instrument<sup>8</sup> (See Appendix A) contains questions designed to produce information describing the effects of day shift work, night shift work, and rotating shift work. The survey design contained two primary areas of study including a descriptive component and the hypotheses. The focus of the instrument was on specific areas where descriptive information was lacking relative to the effects of shift work on individuals who perform police-related duties and where there was disagreement among the experts. These eight areas of interest include:

A. Adaptability of night shift personnel to changing work/sleep habits as measured by:

1. Ease of catching up on lost sleep
2. Ease of sleeping during the day
3. Ability to work at odd times without difficulty
4. Trouble staying awake on the midnight shift
5. Level of alcohol use to assist in sleep
6. Frequency environmental noise interferes with sleep

B. Perceptions of day shift personnel relative to reductions in duty effectiveness attributable to parties and late night activities.

C. Effectiveness of individuals assigned to permanent versus rotating shifts as measured by perceptions of:

1. Frequency of accidents
2. Frequency of disciplinary problems

D. Individual preference for permanent or rotating shifts based upon perceptions of:

1. Effectiveness to perform security duties
2. All factors

E. Similarity of night and day shift workers relative to common sleep habits, including:

1. Normal amount of sleep
2. Level of drowsiness after a night with little sleep
3. Level of difficulty encountered when miss a night's sleep
4. Trouble waking up

F. Descriptions of comparative effects of night versus day work as measured by responses to the following indicators:

1. Use of coffee or tobacco to help stay alert
2. Regularity of sleep
3. Trouble falling asleep
4. Restlessness in sleep
5. Alertness level for effective performance

G. Comparisons of approval for permanent versus rotating shifts, considering:

1. Personal effectiveness
2. All factors

H. Perceptions of shift preferences of family and friends

The survey consists primarily of matrix questions employing a Likert format. Matrix questions require less page space, increase comparability of responses to different questions and are regarded as faster for the respondent to complete. The resulting ordinal data consists of rank-ordered measures of the indicators of each variable.<sup>9</sup> The unit of analysis is the individual.

#### DESCRIPTIVE COMPONENT

The review of the literature resulted in several general conclusions about the effects of shift work on those personnel who perform it. For example, studies presented in Chapter 2 concluded that night and rotating shift workers frequently had a much higher rate of neurotic problems including sleep difficulties and often complained of fatigue. Several survey questions were designed to address this first area of interest and provide data on the

effects of night and rotating shift work on this security police population. Additionally, there was some question as to the potential effects of late night activities on day shift workers. Consequently, one question was designed to provide data toward a conclusion in the second area of interest. Also, some studies concluded that shift workers believed they were more effective in performing perceptual-motor functions while working permanent shifts. Two questions were developed to address this area of interest. Finally, it was important to identify individual shift schedule preferences by the shift workers themselves.

Consequently, several of the survey questions were designed to address this area of inquiry.

#### HYPOTHESES

Certain expectations were also developed about probable perceptions of day and night shift workers based upon the results of the literature review presented in Chapter 2. Consequently, the hypotheses listed below were expressed as directional alternates rather than as null whenever possible. Of course, the null hypothesis was retained in cases where the expectation was that there should be no difference between populations. This was the case in the first interest area where it was expected that if the night shift and day shift populations were essentially the same, there would be little difference in common sleep habits which would be unaffected by potential influences of night or day shift work.

The following hypotheses are presented within the final four of the eight areas of interest outlined above:

A. Similarity of night and day shift workers relative to common sleep habits

$H_{01}$ : There is no difference between night rotating shift workers and day shift workers in terms of the amount of sleep received.

$H_{02}$ : There is no difference between night rotating shift workers and day shift workers in terms of perceived level of drowsiness after a night with little sleep.

$H_{03}$ : There is no difference between night rotating shift workers and day shift workers in terms of perceived ability to handle the loss of a night's sleep.

$H_{04}$ : There is no difference between night rotating shift workers and day shift workers in terms of trouble awakening in the morning.

B. Comparative effects of night versus day work

$H_5$ : Night rotating shift workers will identify more frequent use of caffeine and tobacco products employed to stay alert during duty hours.

$H_6$ : Day shift workers will report more regular sleep than night shift workers.

$H_7$ : Day shift workers will report more ease in falling asleep than night rotating shift workers.

$H_8$ : Night rotating shift workers will report a higher frequency of restless sleep than day shift workers.

$H_9$ : Day shift workers will express a higher degree of alertness during duty than night rotating shift workers.

C. Comparisons of approval for permanent versus rotating shifts

$H_{10}$ : Considering personal effectiveness to perform their security mission, personnel will approve more of the previous permanent shift than the current rotating shift.

$H_{11}$ : Considering all factors, personnel will approve more of the previous permanent shift than the current rotating shift.

D. Perceptions of shift preferences of family and friends

$H_{12}$ : Night shift workers will express the opinion that their family and friends dislike permanent night shifts more than rotating night shifts.

STATISTICAL ANALYSIS

The Behavioral Science Department of the United States Air Force Academy provided some technical assistance in completing the analysis portion of this project. First, they supplied optical scan sheets (General Answer Sheet Type B) for use in recording individual survey responses. Second, they assisted in the initial data analysis using their large system computer employing the Statistical Package for the Social Sciences (SPSS), 2nd edition. These initial results included an overall frequency analysis of responses to each survey item. From the raw data matrix it was apparent that several day shift personnel had responded to questions designated for night shift personnel only and vice

versa. Consequently, these improper responses were hand-removed from the matrix and eliminated from further analysis.

Two analysis methodologies were selected for application to the survey response data. The purely descriptive data collected from a single night or day shift population (in response to the first four areas of interest) were subjected to a simple frequency analysis to provide an understanding of the relative proportions of responses. The data collected in support of the final four areas of interest, however, represented responses from two separate populations. Consequently, the chi square test for two independent samples was applied to the appropriate data sets in order to determine the significance of any difference between the responses of two groups.

The standard nonparametric methodology for determination of chi square was employed using the California State University at Sacramento computer applying the following formula contained in the Statistical Package for the Social Sciences (SPSS), version 8. A level of significance (alpha) of less than or equal to .05 was prespecified for acceptance of independence or, stated otherwise, acceptance of a significant difference between the two response sets.

$$\chi^2 = \text{Sum of } \frac{(O_{ij} - E_{ij})^2}{E_{ij}}$$

Where:

$\chi^2$  = Chi square

$O_{ij}$  = observed number of cases in the i  
row of the j column

$E_{ij}$  = expected number of cases in the i  
row of the j column

df = degrees of freedom equal to  
(r - 1)(k - 1), where r = the  
number of rows and k = the number  
of columns in the data matrix

Observed response frequencies from each of two populations for  
each question were entered into the computer in a matrix format.  
The computer program determined the expected frequencies by  
multiplying the two marginal totals common to each cell and  
dividing that product by the total number of responses. It should  
be noted that on three occasions adjacent matrix cells were  
combined in order to avoid the inaccuracies which reportedly occur  
when 20% or more of the matrix cells have an expected frequency of  
less than five.<sup>10</sup>

#### SUMMARY

During the last week in May, 1985, all shift workers assigned  
to the 320th Security Police Squadron at Mather Air Force Base,  
California completed a survey which included the questions  
presented in Appendix A. Of the 187 total members surveyed, 44  
were assigned to a permanent day shift ("A" Flight) and the  
remainder were assigned to rotating night shifts in the following  
proportions: 46 on "B" Flight, 47 on "C" Flight, and 50 on "D"  
Flight. The survey was designed to provide descriptive data  
relative the effects of day shift and rotating shift work on the

individual. Additionally, because they had been working a permanent shift schedule until approximately five months earlier, personnel were asked for opinions which were used to compare attitudes toward rotating and permanent shift schedules.

Responses were processed from optical scan sheets and data analyzed via the SPSS program in the CSUS computer. A level of significance of less than or equal to .05 was established and the chi square test for independent samples was applied to appropriate data sets. Additionally, relative percentages were calculated for descriptive, single sample data. The results of the analyses may be found in Chapter 4, which follows.

NOTES

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5 Note: Until 1985, the security specialist career field has been restricted to males. This decision was made because of the extensive physical requirements of the job including firing and transporting the M-60 machine gun and carrying heavy equipment when the secondary mission of defending Air Force Bases is necessary. A 1978 feasibility study of employing women in the security specialty was termed a failure. However, a recent memorandum of agreement between the Army and the Air Force transfers responsibility for protection of the exterior of Air Force bases to the Army in times of conflict. Consequently, the Air Force decided to open the career field to women as of 1985. Because of a time lag for recruiting and training, there are not yet any women assigned to the bases.

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7 "An Air Force Almanac: The United States Air Force in Facts and Figures," Air Force Magazine, May 1985, pp. 191 and 195.

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## CHAPTER 4

### Results, Discussion and Conclusions

#### INTRODUCTION

This chapter is divided into two parts. Part I contains the results of the analyses of data described in Chapter 3. As was the case earlier, the presentation is subdivided into the results of the descriptive component and the hypotheses. No interpretation of the results is attempted in this first part of Chapter 4. Part II is subdivided into three sections. The first section is devoted to a summary of the results presented in Part I. The second section contains a discussion of key results along with a brief analysis of possible appropriate management considerations for the 320th Security Police Squadron. Finally, the last section contains a presentation of those primary findings of the research which might appropriately be designated as conclusions.

#### PART I: RESULTS

##### A. DESCRIPTIVE COMPONENT RESULTS

Several survey questions were designed to address the first four areas of interest presented previously in order to provide descriptive data on the perceived effects of shift work on night shift, rotating shift, and day shift populations. The results of the responses to shift work survey questions which addressed each of the four areas follow.

A. Adaptability of night shift personnel to changing work/sleep habits

Table 4.1

Individual Night Shift Responses to the Statement, "After working several late nights in a row, I am able to 'catch up' easily by getting one good night's sleep."

Responses	N	Rel %	Combined %
U. strongly disagree	46	32.4	
Strongly disagree	15	10.6	
Disagree	39	27.5	70.5
Neither agree nor disagree	16	11.3	11.3
Agree	19	13.4	
Strongly agree	4	2.8	
U. strongly agree	3	2.1	18.3
Total N	142		

Fully 70.5% of night shift workers disagreed with the contention that it was easy for them to catch up on their sleep after working several late nights.

Table 4.2

Responses by Night Shift Personnel to the Statement, "I find it easy to sleep during the day when I need to."

Responses	N	Rel %	Combined %
V. strongly disagree	27	19.0	
Strongly disagree	17	12.0	
Disagree	46	32.4	63.4
Neither	10	7.0	7.0
Agree	32	22.6	
Strongly agree	7	4.9	
V. strongly agree	3	2.1	29.6
Total N	142		

More than twice as many night shift respondents reported difficulty than reported ease in sleeping during the day.

Table 4.3

Responses by Night Shift Personnel to the Statement, "I am able to work at odd times of the day or night with little difficulty."

Responses	N	Rel %	Combined %
U. strongly disagree	28	19.9	
Strongly disagree	16	11.3	
Disagree	35	24.8	56.0
Neither agree nor disagree	25	17.7	17.7
Agree	31	22.0	
Strongly agree	3	2.1	
U. strongly agree	3	2.1	26.2
Total N	141		

More than twice as many night shift respondents reported difficulty than reported ease in sleeping at odd times.

Table 4.4

Responses by Night Shift Personnel to the Statement, "When I work the midnight shift, I have trouble staying awake."

Responses	N	Rel %	Combined %
U. strongly disagree	11	7.7	
Strongly disagree	5	3.5	
Disagree	43	30.0	41.2
Neither agree nor disagree	34	23.7	23.8
Agree	28	19.6	
Strongly agree	10	7.0	
U. strongly agree	12	8.4	35.0
Total N	143		

A significant number (35%) of night shift respondents expressed trouble staying awake on the midnight shift.

Table 4.5

Responses by Night Shift Personnel to the Question, "During off-duty hours or days, how often do you use alcohol to help you readjust to a "normal" routine or schedule?"

Responses	N	Rel %
Never	70	49.3
Seldom	24	16.9
Occasionally	29	20.4
Often	10	7.0
Very often	9	6.3
Total N	142	

No significant use of alcohol was reported as attributable to an attempt to assist in normalization of routine .

Table 4.6

Responses by Night Shift Personnel to the Question, "How frequently does noise in your housing interfere with your sleep?"

Responses	N	Rel %
Never	8	5.9
Seldom	29	21.3
Occasionally	48	35.3
Often	25	18.4
Very often	26	19.1
Total N	136	

Fully 72.8% of respondents reported at least occasional sleep problems caused by noise.

B. Perceptions of day shift personnel relative to reductions in duty effectiveness attributable to parties and late night activities

Table 4.7

Responses by Day Shift Personnel to the Statement, "Late night activities and parties sometimes interfere with my effectiveness in performing my security mission while working this shift."

Responses	N	Rel %	Combined %
V. strongly disagree	8	19.0	
Strongly disagree	6	14.3	
Disagree	9	21.4	54.7
Neither agree nor disagree	4	9.5	9.5
Agree	7	16.7	
Strongly agree	4	9.5	
V. strongly agree	4	9.5	35.7
Total N	42		

Fully 35.7% of day shift respondents reported a decrease in effectiveness due to late night activities.

C. Effectiveness of individuals assigned to rotating versus permanent shifts

Table 4.8

Responses by All Shift Workers to the Statement, "We have fewer accidents involving flight personnel when working;"

Responses	N	Rel %
Permanent shifts	102	57.6
Rotating shifts	75	42.4
Total N	177	

15.2% more respondents believed they had fewer accidents when working permanent shifts.

Table 4.9

Responses by All Shift Workers to the Statement, "We have fewer disciplinary problems on flight when working:"

Responses	N	Rel %
Permanent shifts	108	61.0
Rotating shifts	69	39.0
Total N	177	

22% more respondents believed they had fewer disciplinary when working permanent shifts.

D. Preference for permanent or rotating shifts

D<sub>1</sub>: Shift preference considering effectiveness to perform security duties.

This area was investigated by examining the responses to the statement presented in Table 4.10A below. Additionally, pertinent management planning data was collected and is contained in Table 4.10B which follows.

Table 4.10A

Comparison of the Responses of All Shift Workers to the Statement, "Now that I've thought about it more, I think the best shift for me to work in terms of my effectiveness to perform security police duties is:"

Responses	N	Rel %	Combined %
Rotating swings/mids	30	16.9	
Rotating days/swings/mids	4	2.2	19.1
Permanent days	77	43.3	
Permanent swings	37	20.8	
Permanent mids	12	6.7	
"Permanent" shifts*	18	10.1	80.9
Total N	178		

Fully 43.3% of all responding selected permanent day shifts as their choice for maximization of effectiveness. The next highest category was permanent swing shifts with 20.8%. Interestingly,

80.9% chose some form of permanent shift as opposed to the 19.1% who selected a form of rotating shift.

Table 4.10B

Responses of All Shift Workers to the Statement, "Considering only personal effectiveness in terms of your job, if you were assigned to a permanent shift, would you choose: "

Responses	N	Rel %
Day shift	97	51.9
Swing shift	51	27.3
Midnight shift	39	20.8
Total N	187	

Respondents apparently prefer a day shift assignment when considering personal effectiveness to perform their security mission.

## D2: Overall shift schedule preference

This area was examined by comparing responses to survey items as presented in the following three tables. Table 4.11 presents responses to a request for overall shift preference early in the survey while Table 4.12 presents data from a nearly identical question toward the end of the survey. Table 4.13 presents the results of a much more simplified version of the question designed to elicit a response to the most basic question of permanent versus rotating shift preference.

Table 4.11

Responses of all Shift Workers to the Statement, "Overall, the schedule I most prefer to work is:"

Responses	N	Rel %	Combined %
Rotating swings/mids	24	13.6	13.6
Permanent days	82	46.6	
Permanent swings	33	18.7	
Permanent mids	19	10.8	
"Permanent" shift rotating at college breaks	18	10.2	86.3*
Total N	176		

\* Total does not add to 100%, due to rounding

It should be noted that a chi-square comparison of overall shift choice in Table 4.11 with the choice for maximum nonconsecutive

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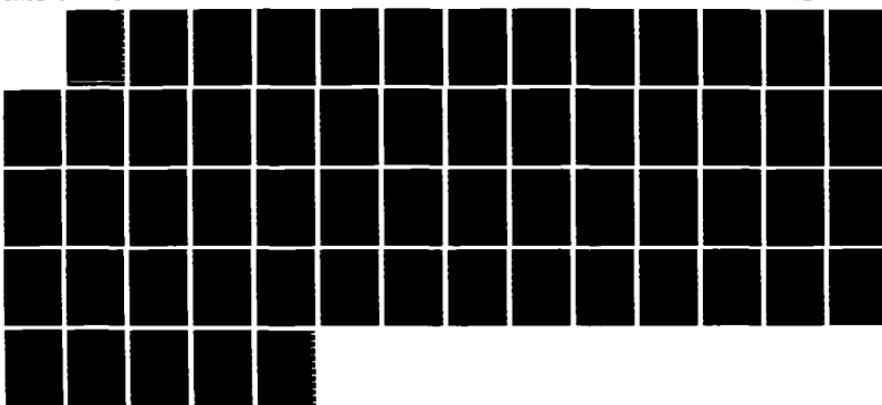
EFFECTS OF SHIFT WORK ON AIR FORCE SECURITY POLICE  
PERSONNEL (U) AIR FORCE INST OF TECH WRIGHT-PATTERSON  
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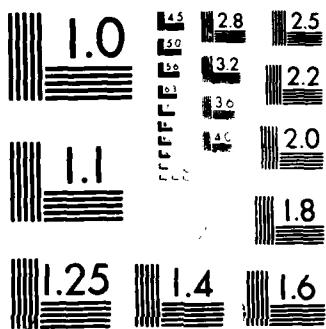
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effectiveness in Table 4.10A reveals that the difference between the two response sets is not significant ( $\alpha = .1381$ ).

Table 4.12

Responses of All Shift Workers to the Statement, "Overall, to do my best work and still maintain a good family/social life, the best schedule for me is:"

Responses	N	Rel %	Combined %
Rotating swings/mids	29	16.7	16.7
Permanent days	93	53.4	
Permanent swings	38	21.8	
Permanent mids	7	4.0	
"Permanent" shift rotating at college breaks	7	4.0	83.2*
Total N	174		

\* Total does not add to 100% due to rounding

It must also be noted, however, that a chi square comparison of the early responses from Table 4.11 with the later responses from Table 4.12 results in a significant difference between the two ( $\alpha = .0182$ ). As a result, there is some question of reliability in these results. Respondents overwhelmingly preferred permanent over rotating shifts in their responses to both questions; however, a higher proportion of shift workers

chose permanent day shift assignment in response to the later question.

Table 4.13

Responses of All Shift Workers to the Statement, "If you had a choice, would you choose: "

Responses	N	Rel %
Permanent shift	109	58.3
"Permanent" shift rotating at college breaks	31	16.6
Rotating shift	47	25.1
Total N	187	

It is apparent that the vast majority of respondents preferred permanent over rotating shift. Combining permanent and "permanent" shift choices reveals that 74.9% of the shift workers would select permanent over rotating shifts if given the choice.

## B. HYPOTHESES

The hypotheses presented earlier were tested by analyzing responses by day shift and night shift security police personnel to questions on the shift work survey in Appendix A. As discussed in the previous chapter, the chi square test for two independent samples was applied to the appropriate data sets and a level of significance of less than or equal to .05 was prespecified for acceptance of independence. The following results were grouped in the same order as previously presented and contain no interpretation. A discussion section follows, however, which presents some elementary interpretation of the results of the data analysis.

### A. Similarity of night and day shift workers relative to common sleep habits.

$H_01$ : There is no difference between night rotating shift workers and day shift workers in terms of the amount of sleep received.

This hypothesis was tested by comparing responses of night rotating shift and day shift workers to the question presented in Table 4.14 which follows.

Table 4.14

Comparison of Night and Day Shift Responses to the Question, "How many hours of sleep do you typically get after working your current schedule?"

Responses	Night	Rel %	Day	Rel %
9 or more	14	10.2	3	6.8
8	25	18.2	5	11.4
7	26	19.0	9	20.5
6	45	32.8	17	38.6
5 or less	27	19.7	10	22.7
Total N	137		44	

Chi square = 1.87442

Significance level = .7588

The null hypothesis is accepted. The night shift and day shift populations receive essentially the same amount of sleep.

$H_02$ : There is no difference between night rotating shift workers and day shift workers in terms of perceived level of drowsiness after a night with little sleep.

This hypothesis was tested by comparing responses of night and day shift workers to the statement presented in Table 4.15 below.

Table 4.15

Comparison of Night and Day Shift Responses to the Statement,  
"After a night with little sleep, I feel drowsy the next day."

Responses	Night	Rel %	Day	Rel %
V. strongly disagree	11	8.4	1	2.4
Strongly disagree	7	5.3	4	9.8
Disagree	18	13.7	7	17.1
Agree	48	36.6	9	22.0
Strongly agree	25	19.1	12	29.3
V. strongly agree	22	16.8	8	19.5
Total N	131		41	

Chi square = 6.44944

Significance level = .2649

The null hypothesis is again accepted. Both night shift and day shift workers agreed (72.5% and 70.8%) that they feel drowsy after a night with little sleep.

$H_03$ : There is no difference between night rotating shift workers and day shift workers in terms of perceived ability to handle the loss of a night's sleep.

This hypothesis was tested by comparing responses of night and day shift workers to the statement presented in Table 4.16 below.

Table 4.16

Comparison of Night and Day Shift Responses to the Statement, "I am the kind of person who can easily miss out on a night's sleep without it bothering me."

Responses	Night	Rel %	Day	Rel %
Disagree*	116	86.6	31	72.1
Agree	18	13.4	12	27.9
Total N	134		43	

Chi square = 4.845

Significance level = .0277

\*Note: All "agree" categories were combined and all "disagree" categories were combined to bring the number of cells with expected values of less than 5 to less than 20% of all cells.

The null hypothesis must be rejected in that the night shift population is apparently slightly more bothered by missing a night's sleep than the day shift population.

$H_04$ : There is no difference between night rotating shift workers and day shift workers in terms of trouble awakening in the "morning."

This hypothesis was tested by comparing responses of day and night shift workers to the statement presented in Table 4.17 below. "I have trouble waking up in the morning."

Table 4.17  
Comparison of Night and Day Shift Responses to the Statement, "I have trouble waking up in the morning."

Responses	Night	Rel%	Day	Rel %
Strongly disagree*	25	21.7	15	39.5
Disagree	36	31.3	8	21.1
Agree	29	25.2	6	15.8
Strongly agree	25	21.7	9	23.7
Total N	115		38	

Chi square = 5.638

Significance level = .1306

Note: "Very strongly" and "strongly" cells were combined to bring the number of cells with expected values of less than 5 to less than 20% of all cells.

The null hypothesis, then, is accepted in that the responses of the two populations are not significantly different.

#### B. Comparative effects of night versus day work.

H<sub>5</sub>: Night rotating shift workers will identify more frequent use of caffeine and tobacco products employed to stay alert during duty hours.

This hypothesis was tested by comparing responses of night and day shift workers to the statement presented in Table 4.18 below.

Table 4.18

Comparison of Night and Day Shift Responses to the Statement, "I often use caffeine or tobacco products to help me stay alert during duty hours."

Responses	Night	Rel %	Day	Rel%
Very strongly disagree	26	20.3	6	15.8
Strongly disagree	8	6.3	4	10.5
Disagree	24	18.8	12	31.6
Agree	36	28.1	7	18.4
Strongly agree	12	9.4	4	10.5
Very strongly agree	22	17.2	5	13.2
Total N	128		38	

Chi square = 4.67386

Significance level = .4579

The hypothesis must be rejected in that the difference in responses of the two populations was not significant.

$H_5$ : Day shift workers will report more regular sleep than night shift workers.

This hypothesis was tested by comparing responses of night rotating shift workers and day shift workers to the question presented in Table 4.19 below.

Table 4.19

Comparison of Night and Day Shift Responses to the Question, "How regular is your sleep after working your current schedule?"

Responses	Night	Rel %	Day	Rel %
Very regular	8	5.7	6	13.6
Fairly regular	47	38.3	21	47.7
Fairly irregular	56	39.7	12	27.3
Very irregular	30	21.3	5	11.4
Total N	141		44	

Chi square = 7.85449

Significance level = .0491

The hypothesis is accepted in that significantly more day shift workers reported regular sleep (61.7%) than did night rotating shift workers (39%).

H<sub>7</sub>: Day shift workers will report more ease in falling asleep than night rotating shift workers.

This hypothesis was tested by comparing responses of night and day shift workers to the question presented in Table 4.20 below.

Table 4.20

Comparison of Night and Day Shift Responses to the Question, "How often do you have trouble falling asleep after working your current schedule?"

Responses	Night	Rel %	Day	Rel%
Never	17	11.9	11	25
Seldom	36	25.2	18	40.9
Occassionally	53	37.1	11	25.0
Often	26	18.2	2	4.5
U. often	11	7.7	2	4.5
Total N	143		44	

Chi square = 12.836.9

Significance level = .0121

The hypothesis is accepted in that night rotating shift workers reported significantly more frequent problems falling asleep than day shift workers.

H<sub>8</sub>: Night rotating shift workers will report a higher frequency of restless sleep than day shift workers.

This hypothesis was tested by comparing the responses of night rotating shift workers and day shift workers to the question presented in Table 4.21 below.

Table 4.21

Comparison of Night and Day Shift Responses to the Question, "After working this schedule, how often is your sleep interrupted by periods of restlessness?"

Responses	Night	Rel %	Day	Rel %
Never	8	5.6	10	23.3
Seldom	35	24.6	18	41.9
Occassionally	54	38.0	13	30.2
Often/V. Often	45	31.7	2	4.7
Total N	142		42	

Chi square = 23.999

Significance level = .0000

The hypothesis is accepted in that night rotating shift workers reported significantly more frequent periods of restless sleep than day shift workers.

H<sub>0</sub>: Day shift workers will express a higher degree of alertness during duty than night rotating shift workers.

This hypothesis was tested by comparing the responses night rotating shift workers and day shift workers to the statement in Table 4.22 below.

Table 4.22

Comparison of Night and Day Shift Responses to the Statement, "I feel alert and effective in performing my security mission while working this shift schedule."

Responses	Night	Rel %	Day	Rel %
strongly disagree*	29	27.1	3	7.7
disagree	32	29.9	8	20.5
agree	32	29.9	12	30.8
strongly agree	14	13.1	16	41.0
Total N	107		39	

Chi square = 15.70087

Significance Level = .0008

\*Note: very strongly and strongly cells were combined to bring the number cells with expected values of less than 5 to less than 20% of all cells.

The hypothesis is accepted in that significantly more day shift workers agreed they were effective in performing their duties than did night rotating shift workers.

C. Comparisons of approval for permanent versus rotating shifts

H<sub>10</sub>: Considering personal effectiveness to perform their security mission, personnel will approve more of the previous permanent shift than the current rotating shift.

This hypothesis was tested by comparing the responses to the questions presented in Table 4.23 below.

Table 4.23

Comparison of Responses of All Shift Workers<sup>1</sup> to the Following:

Question 5: "Considering your personal effectiveness to respond to security incidents, how do you feel about your previous permanent shift schedule?"

Question 6: "Considering your personal effectiveness to respond to security incidents, how do you feel about your current (permanent days with rotating swings/mids) shift schedule?"

Responses	Question 5	Rel %	Question 6	Rel %
Like(d) v. much	30	17.9	31	17.8
Like(d)	22	13.1	28	16.1
Neither	33	19.6	30	17.2
Dislike(d)	36	21.4	44	25.3
Dislike(d) v. much	47	28.0	41	23.6
Total N	168		174	

Chi square = 1.98369      Significance level = .7388

The hypothesis is rejected in that personnel responded similarly toward approval of both methodologies. In fact, of those with an opinion, 61.5% of respondents disapproved of the permanent shift

as compared with 59% disapproval for the rotating shift when considering effectiveness.

H<sub>jj</sub>: Considering all factors, personnel will approve more of the previous permanent shift than the current rotating shift.

This hypothesis was tested by comparing the responses to the questions presented in Table 4.24 below.

Table 4.24\*

Comparison of the Responses of All Shift Workers to the Following:  
 Question 7: "Considering all factors (family, personnel, social, job effectiveness, etc.), how do you feel about your previous permanent shift schedule?"

Question 8: "Considering all factors (family, personal, social, job effectiveness, etc.), how do you feel about your current (permanent days with rotating swings/mids) shift schedule?"

Responses	Perm.	Rel %	Rot.	Rel %
Like(d) v. much	38	30.9	45	32.1
Like(d)	32	26.0	28	20.0
Dislike(d)	31	25.2	37	26.4
Dislike(d) v. much	22	17.9	30	21.4
Total N	123		140	

Chi square = 1.52472

Significance level = .6766

\*Note: "Neither approve nor disapprove" responses were not considered in the analysis.

The hypothesis may not be accepted in that personnel responded with similar approval of both shift schedules. In fact, combining liked very much and liked catagories, 56.7% liked the permanent shift while 52.1% liked the rotating shift schedule overall.

D. Perceptions of shift preference of family and friends

H<sub>12</sub>: Night shift workers will express the opinion that their family and friends dislike permanent night shifts more than rotating night shifts.

This hypothesis was tested by comparing responses by night shift personnel to questions 9 and 10 of the survey as presented in Table 4.25 below. Day shift personnel worked the same schedule in either system. Consequently, day shift responses were not considered in the analysis.

Table 4.25  
Comparison of the Responses of Night Shift Workers to the Following:

Question 9. "How did your family, girlfriend or close friends feel about your previous (permanent) shift schedule?"

Question 10. "How do your family, girlfriend or close friends feel about your current (rotating) shift schedule?"

Responses	Rot.	Rel %	Perm	Rel %
Like(d) very much	41	32.0	49	40.8
Like(d) more than dislike	20	15.6	21	17.5
Neither	16	12.5	11	9.2
Dislike(d) more than like(d)	32	25.0	19	15.8
Dislike(d) very much	19	14.8	20	16.7
Total N	128		120	

Chi square = 4.74767

Significance level = .3142

This hypothesis cannot be accepted in that the responses were very similar between the two questions. In fact, however, respondents reported that a total of 51% of their families and friends disliked rotating shifts while only 39% disliked permanent shifts.

### PART III: SUMMARY, DISCUSSION AND CONCLUSIONS

The first subsection of this part of Chapter 4 was designed to clarify graphically the data analysis by presenting summaries of the results of the elements of both the descriptive component of the survey and the hypotheses. The summary is followed by a brief discussion of the perceived meaning and implications of the research results. Finally, Chapter 4 ends with a presentation of the conclusions of this study.

#### A. SUMMARY

As previously explained, the shift work survey questions presented to Mather AFB security police personnel were designed to investigate several major areas of interest. These major areas were subdivided into a descriptive component and a group of hypotheses to be tested. A graphic summary of the results within the two major subdivisions follows.

The primary purpose of a major portion of the shift work survey was to provide descriptive data on the perceived effects of day, night, and rotating shift work on the Mather AFB security police personnel who work them. Table 4.26 below was designed to summarize the results of each area of interest within the descriptive component.

Table 4.26  
Summary of Descriptive Component Results

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#### Adaptability of night shift personnel to changing work/sleep habits

1. Night shift workers reported difficulty (70.5%) in catching up on sleep after working several late nights in a row.

2. Night shift workers reported problems (63.4%) sleeping during the day.
3. Night shift workers reported problems (56%) working at odd times of the day or night.
4. Many night shift workers reported difficulty (35%) staying awake on the midnight shift.
5. Night shift workers reported little use of alcohol to help them adjust their wake/sleep schedules.
6. Night shift workers reported significant problems with sleep attributable to noise.

**Perceptions of day shift personnel relative to reductions in duty effectiveness attributable to parties and late night activities**

7. Day shift workers reported decreased work effectiveness (35.7%) due to late night activities and parties.

**Effectiveness of individuals assigned to rotating versus permanent shifts**

8. Shift workers believed they have fewer accidents while working a permanent (56.6%) versus a rotating (42.4%) shift.
9. Shift workers believed they have fewer disciplinary problems while working permanent (61%) versus rotating (39%) shifts.

**Preference for permanent or rotating shifts**

10. In terms of effectiveness to perform their duties, shift workers preferred permanent shifts over rotating shifts with an emphasis on permanent day shift assignment.
11. Overall (ie. considering both job performance and social life), shift workers preferred permanent shifts over rotating shifts.

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The hypotheses presented earlier were tested by analyzing responses of day and night shift security police personnel to similar questions on the shift work survey. Table 4.27, which follows, contains a summary of the results of the analyses.

Table 4.27  
Summary of Hypotheses Tested

Hypothesis	Accepted	Rejected
H <sub>1</sub> : There is no difference between night rotating shift workers and day shift workers in terms of the amount of sleep received.		X
H <sub>2</sub> : There is no difference between night rotating shift workers and day shift workers in terms of perceived level of drowsiness after a night with little sleep.		X
H <sub>3</sub> : There is no difference between night rotating shift workers and day shift workers in terms of perceived ability to handle the loss of a night's sleep.		X
H <sub>4</sub> : There is no difference between night rotating shift workers and day shift workers in terms of trouble waking up in the "morning."		X
H <sub>5</sub> : Night rotating shift workers will identify more frequent use of caffeine and tobacco products employed to stay alert during duty hours.		X
H <sub>6</sub> : Day shift workers will report more regular sleep than night shift workers.		X
H <sub>7</sub> : Day shift workers will report more ease in falling asleep than night shift workers.		X
H <sub>8</sub> : Night rotating shift workers will report a higher frequency of restless sleep than day shift workers.		X
H <sub>9</sub> : Day shift workers will express a higher degree of alertness during duty than night rotating shift workers.		X

Hypothesis	Accepted	Rejected
H <sub>10</sub> : Considering personal effectiveness to perform their security mission, personnel will approve more of the previous permanent shift than the current rotating shift.		X
H <sub>11</sub> : Considering all factors, personnel will approve more of the previous permanent shift than the current rotating shift.		X
H <sub>12</sub> : Night shift workers will express the opinion that their family and friends dislike permanent shifts more than rotating shifts.		X

## B. DISCUSSION

The purpose of this section of Chapter 4 is to present some of the limiting factors discovered in the survey and discuss some of the results as they may relate to the management of a critical security police mission. Major areas of discussion include sleep problems associated with night shift work, perceptions of effectiveness, and shift schedule preference.

### 1. LIMITING FACTORS

The survey instrument (See Appendix A) created several problems for analysis and reporting. First, the questionnaire failed to include sufficient demographic data to identify which respondents worked which shift during the permanent shift schedule employed prior to January 1985. Had the responses served to identify exactly which schedule each respondent worked at a given time, further analysis may have clarified the inconclusive results evident in hypotheses 10, 11, and 12 (to be discussed later in more detail.) Additional

demographic information to include marital and parental status, age, residence type (i.e. house, apartment, dormitory), and length of shift work experience would also have afforded additional meaningful analysis. Finally, it is possible that the length and complexity of the survey instrument (which also contained questions on another unrelated subject) may have contributed to measurement problems.

## 2. SLEEP PROBLEMS AND NIGHT SHIFT WORK

Upon examination of the responses of both day and night shift workers, several points become apparent. First, both populations were very similar with respect to common sleep habits not related to shift work. Second, night and rotating shift workers reported significantly more sleep problems related apparently to their work/sleep cycle. Finally, night rotating shift workers reported problems adapting to the the changing work/sleep cycles required of them.

The acceptance of hypotheses one, two and four provides support for an assumption that the Mather AFB day and night shift populations were very similar in their nonshift-related sleep habits. Both populations reported similar sleep totals. There was no significant difference between them in the level of drowsiness perceived after a night with little sleep, nor was there a significant difference in level of difficulty waking up in the "morning." Night shift workers, however, reported slightly more difficulty encountered in missing a night's sleep.

However, night rotating shift workers reported a significantly higher level of work schedule-related sleep problems. The results of the data presented in Tables 4.19, 4.20 and 4.21 illustrate this point. Analysis revealed that night shift workers reported much less regularity of sleep, more trouble falling asleep, and more frequent restlessness of sleep than their day shift counterparts.

Additionally, survey responses by night shift workers indicated difficulty adapting to changing work/sleep habits. The first section of Table 4.26 contains information which illustrates this point. Night shift workers reported difficulty (70.5%) catching up on sleep, problems (63.4%) sleeping during the day, and significant sleep problems attributable to environmental noise.

Clearly, night shift work was seen to have contributed to sleep problems among the night shift population. Security police management must be aware of the effects of night shift work on the quality and quantity of sleep among those who perform it and make an effort to influence those factors under their control in order to minimize reductions in individual effectiveness and job satisfaction. Possible management actions might include controlling the amount of overtime night shift personnel are required to work and providing dormitory residents with both light and sound insulation as well as supervision to minimize environmental noise levels. Management should also be aware that the data from this study provide some support for a conclusion

that sleep problems by night and rotating shift personnel contribute to a perceived decrease in job effectiveness.

### 3. PERCEPTIONS OF EFFECTIVENESS

Shift work survey questions also employed several indicators in examining perceptions of job effectiveness. Both day and night shift personnel responded to a statement concerning their effectiveness to perform their duties. Additionally, all personnel responded to statements indicating on which shift format they experience the fewest accidents and disciplinary problems. Day shift workers gave their opinions on the effects of late night activities on their job performance. Finally, night shift workers registered their level of difficulty in staying awake on the midnight shift.

Table 4.22 contains data from both day and night shift workers in response to the statement "I feel alert and effective in performing my security police mission while working this shift schedule." It is important to note that significantly more night shift (57%) workers disagreed with this statement than day shift (28.2%) workers. Clearly, night shift workers feel less effective than day shift workers.

All respondents were asked if they had fewer accidents and disciplinary problems on permanent or rotating shift schedules. The majority of respondents agreed that there were fewer accidents (57.6%) and fewer disciplinary problems (61%) when they were assigned to permanent shifts as opposed to rotating shifts.

Another important source of reduced effectiveness was identified by day shift personnel. Fully 35.7% agreed that late night activities and parties sometimes interfered with their effectiveness in performing their duties.

Finally, night shift personnel clearly revealed a source of reduced effectiveness when 35% advised they had trouble staying awake on the midnight shift.

Again, this section contains key information for consideration by interested security police managers. While night shift workers feel significantly less effective in their jobs than day shift workers, it is also important to note that many day shift workers believe their effectiveness is reduced by late night activities. Further, closer supervision of midnight shift workers may be warranted due to the reported tendency to have difficulty staying awake during that time. Finally, management should carefully consider implementation of a permanent shift work schedule because workers believe they are more effective (i.e. have less accidents and disciplinary problems) while working permanent as opposed to rotating shifts.

#### 4. SHIFT SCHEDULE PREFERENCE

Another goal of this study was to determine the shift schedule format preference of those security policemen who worked shift work. First, in an area that was thought to be related to shift preference, respondents were asked how they felt about their previous (permanent) shift schedule and their current (rotating) shift schedule in terms of job effectiveness and considering all

factors (i.e. job effectiveness, social and family considerations.) Respondents were also asked to estimate how their family and close friends felt about both the permanent shift and rotating shift schedules. Finally, a number of questions were included in the survey in order to elicit specific responses of shift schedule preference when considering effective job performance and when considering all factors.

The first two areas of inquiry led to confusing results. It might have been expected that, since the majority agreed that they had both fewer accidents and disciplinary problems on a permanent shift schedule, respondents would "like" permanent shifts better when considering personal effectiveness. Actual survey results, however, indicated that shift workers were in relative agreement that they disliked both schedules about equally. A similar analysis of responses pertaining to overall feelings about the two schedules also resulted in no significant statistical difference. The lack of sufficient demographic data may have contributed to the confusing results in that all responses were necessarily included in the analysis rather than only those from individuals who had worked night shifts (day shift schedules were the same) under both schedules.

Similarly inconclusive were the results of the estimations of how family and friends felt about both the permanent and rotating shift schedules. The hypothesis that they would prefer the rotating shift schedule was based upon conclusions by Paul Mottz and others (see Social Considerations in Chapter 2) which implied

that the intensity of conflict brought about by shift work is directly related to the level of conflict between the worker's individual needs and goals. Originally it was assumed, for example, that the majority of the night shift respondents would experience more social (dating) and family conflict while working a permanent evening shift since that schedule would effectively bar evening social and family contact for six days at a time. That assumption may indeed still be true, however, in that the survey instrument failed in limiting responses to the appropriate target subgroup.

Responses to direct requests for identification of shift schedule preferences, however, were more conclusive. When asked which shift would be best in terms of job effectiveness, respondents clearly chose permanent (80.9% overall) shift schedules (see Table 4.10A). Finally, when asked either which shift schedule they would choose (see Table 4.13) or which schedule they would prefer overall (see Tables 4.11 and 4.12) respondents overwhelmingly selected permanent over rotating shift methodologies. A tendency for day shift selection was noted in both areas.

Clearly, then, Mather security police day and night shift workers indicated they would choose permanent shift scheduling methods over rotating shifts both overall and when considering only effective performance of their duties. Consequently, the management problem would not seem to be the choice between the scheduling methodologies but the fact that an average of 47.7% of

workers would prefer to work a permanent day shift when only 35-40% of them may be normally assigned to the day shift.

#### C. CONCLUSIONS

The data from the survey of flight personnel assigned to the 320th Security Police Squadron at Mather AFB, California have provided some useful information in understanding the effects of shift work on both day and night shift workers there. In light of the previous discussion, several points appear to take on such key importance as to warrant presentation as conclusions. These conclusions are listed below:

1. Mather night and rotating shift workers reported significantly more work-related sleep problems than day shift workers even though both groups were similar in their nonduty-related sleep habits.
2. Possibly related to the above conclusion, the perceived level of job effectiveness was significantly lower in the night shift workers than the day shift workers.
3. The majority of these security policemen believed they had fewer accidents and disciplinary problems (ie. were more effective) while working a permanent as compared with a rotating shift schedule.
4. Many day shift workers reported that late night activities, including parties, interfered with their job effectiveness.
5. A significant number of night shift workers reported difficulty staying awake on the midnight shift.

6. This group of security police personnel clearly preferred to work a permanent shift schedule over a rotating shift schedule.

The final chapter of this thesis, which follows, was designed as an executive summary for those who have the time to read only a synopsis of the study. Additionally, Chapter 5 contains a discussion of implications for future research in this vital area.

## NOTES

<sup>1</sup> All responses were considered in the analysis of this data and that considered for presentation in Table 4.24 because insufficient demographic data was collected to indicate what schedule each respondent worked prior to the January 1985 format change from permanent to rotating night shifts.

<sup>2</sup> Paul E. Mott, and others, Shift Work: The Social, Psychological and Physical Consequences (Ann Arbor: The University of Michigan Press, 1965), p.289.

## CHAPTER 5

### Summary

#### INTRODUCTION

The purpose of this study was twofold. The first objective was to present a detailed review of the current literature pertaining to the effects of shift work on those who perform it, concentrating on police-related vigilance type functions. The second objective was to complete research directed toward obtaining specific information about the effects of shift work on a population of US Air Force security police personnel in order to form conclusions which might be employed by other management specialists to maximize individual effectiveness and minimize risk both to those personnel and the people and property they protect. This chapter, then, is divided into two primary sections: the summary and implications for future research.

#### SUMMARY

##### A. Literature Review

The early literature describes scientific observations and studies which characterize the presence of certain biological rhythms which control many functions in both plants and animals. These rhythms, later named "circadian rhythms" were found to be altered eventually by changes in environmental light/dark cycles and were apparently genetically inherited by offspring.

More recently, researchers identified a number of functions in man which are affected by these circadian rhythms, including: alertness, body temperature, blood physiology, blood pressure, digestion, galvanic skin response, hormone secretion, kidney function, liver function, menstrual cycles, performance, pulse rate, respiration, sensitivity to drugs, sensitivity to pain, sleep/wake cycles. Further investigation revealed that shift work frequently required changes in eating, working, socializing, and sleeping timetables and that these changes tend to desynchronize circadian control. The preponderance of the evidence indicates that sleep disorders, fatigue, headaches, moodiness, and digestion problems to include ulcers, changes in appetite and constipation occur more frequently in shift workers. There is, in fact, a virtual consensus that these ailments increase in both incidence and severity in shift workers who rotate among shifts.

Because of the apparent decrease in physiological efficiency in shift workers, a review of the literature pertaining to human performance efficiency was undertaken. Field experiments provide virtual agreement that human effectiveness in job performance is low during night shifts with minimal efficiency and, conversely, maximum danger of errors between 10 p.m. and 3 a.m. The results of experimental studies tend to differ according to two categories: perceptual-motor performance and cognitive performance. Experiments which measure the speed and accuracy of response to simple audio and visual stimuli (perceptual-motor) indicate that effectiveness increases throughout the morning.

experiences a slight "post-lunch dip", followed by a recovery and increase to a maximum level at approximately 9 p.m. Performance typically begins to decrease at that time, falling to a low at approximately 3 a.m. Significantly, it was also found that individual circadian rhythms tend to shift as a worker changes his work-sleep cycle. This conclusion lends support to the idea that adaptation can effectively occur in individuals who work the same shift "permanently". Cognitive performance tests produced slightly different results in that the more complex tasks which required significant verbal reasoning and/or short term memory tend to peak in late morning.

The above results, of course, raise the question of which shift arrangement is best for maximizing worker effectiveness levels. While there is not total agreement among the experts in the field, Dr. Simon Folkard seems to present the majority opinion when he advises that the demands of the task and the type of shift system interact with each other via the worker's circadian rhythms in determining performance. He further counsels that permanent shift systems are clearly superior when high levels of performance efficiency and safety must be maintained in night shift work comprised of primarily perceptual-motor tasks. Folkard also advises, however, that rapidly rotating shift schedules are best for more cognitive, memory-loaded tasks.<sup>1</sup>

Additionally, there is a growing body of research which describes significant differences in the levels and ease with which individuals tolerate shift work. Studies based upon

"morning type" and "evening type" personalities (chronotypes) conclude that "morning types" tend to have more difficulty adapting their circadian rhythms to rotating shifts. Conversely, "evening types" constantly adapt and are more functional in the shift work environment. These studies support a conclusion that identification of chronotype may have some value in predicting if an individual is more suitable for shift work than others.

Social considerations have also been found to affect the individual worker. Clearly, a worker's social life is frequently affected by a requirement to work night or rotating shift work. It appears that the intensity of the results is related to the level of conflict between the schedule and the worker's needs and goals. Consequently, a young mother or father who values highly their contribution to spouse and children will probably experience a significant amount of stress. This stress may result in behavior which aggravates the family relationship and may also translate into physical symptoms. The family-oriented person who has problems physically adjusting to shift work, then, will have a tremendous difficulty with a night or rotating shift schedule. Therefore, management may again benefit from a procedure for identifying individuals who are least adaptable to shift work from a social perspective.

In light of the above conclusions relating to decreased vigilance, increased potential for error, and the potential for family difficulties it is incumbent upon police managers to examine their policies toward police personnel. The importance

of this task becomes even more apparent when it is discovered that the time of day when most officers are killed in the line of duty is also the time of day when the above described studies show they are likely to be least effective. Since patrol officers perform functions which may be classified as almost exclusively perceptual-motor, the preponderence of the literature supports a decision to employ a permanent or semi-permanent duty schedule. However, there have been few studies which test the individual opinions of effectiveness in personnel who perform police-type functions.

#### B. Research

The research portion of this study was designed to explore the effects of shift work on individual US Air Force security police shift workers with an emphasis on collecting data to support well-informed management decisions directed toward maximization of security police effectiveness.

During the last week in May, 1985, all shift workers assigned to the 320th Security Police Squadron at Mather Air Force Base, California completed a survey which included the questions presented in Appendix A. Of the 187 total members surveyed, 44 were assigned to a permanent day shift ("A" Flight) and the remainder were assigned to rotating night shifts in the following proportions: 46 on "B" Flight, 47 on "C" Flight, and 50 on "D" Flight. The survey was designed to provide descriptive data relative the effects of day shift and rotating shift work on the individual. Additionally, because they had been working a

permanent shift schedule until approximately five months earlier. personnel were asked for opinions which were used to compare attitudes toward rotating and permanent shift schedules.

Responses were processed from optical scan sheets and data analyzed via the SPSS program in the CSUS computer. A level of significance of less than or equal to .05 was established and the chi square test for independent samples was applied to appropriate data sets. Additionally, relative percentages were calculated for descriptive, single sample data.

### C. Results

The eight original areas of inquiry addressed through the shift work survey may be divided into two primary categories: the descriptive component and the hypotheses. The primary purpose of the descriptive component was to provide descriptive data on the perceived effects of day, night, and rotating shift work on the Mather AFB security police flight population. A summary of the results of this category was previously presented as Table 4.26 and is presented below as Table 5.1.

Table 5.1  
Summary of Descriptive Component Results

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#### Adaptability of night shift personnel to changing work/sleep habits

1. Night shift workers reported difficulty (70.5%) in catching up on sleep after working several late nights in a row.
2. Night shift workers reported problems (63.4%) sleeping during the day.
3. Night shift workers reported problems (56%) working at odd times of the day or night.

4. Many night shift workers reported difficulty (35%) staying awake on the midnight shift.
5. Night shift workers reported little use of alcohol to help them adjust their wake/sleep schedules.
6. Night shift workers reported significant problems with sleep attributable to noise.

**Perceptions of day shift personnel relative to reductions in duty effectiveness attributable to parties and late night activities**

7. Day shift workers reported decreased work effectiveness (35.7%) due to late night activities and parties.

**Effectiveness of individuals assigned to rotating versus permanent shifts**

8. Shift workers believed they have fewer accidents while working a permanent (56.6%) versus a rotating (42.4%) shift.
9. Shift workers believed they have fewer disciplinary problems while working permanent (61%) versus rotating (39%) shifts.

**Preference for permanent or rotating shifts**

10. In terms of effectiveness to perform their duties, shift workers preferred permanent shifts over rotating shifts with an emphasis on permanent day shift assignment.
11. Overall (i.e. considering both job performance and social life), shift workers preferred permanent shifts over rotating shifts.

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Within the second category, hypotheses were developed to test the similarity of sleep habits common to both the day and night shift populations and to examine the relationships of responses of each group relative to expectations identified from the literature review. A summary of the results from this category was previously presented as Table 4.27 and follows as Table 5.2.

Table 5.2  
Summary of Hypotheses Tested

Hypothesis	Accepted	Rejected
H <sub>1</sub> : There is no difference between night rotating shift workers and day shift workers in terms of the amount of sleep received.	X	
H <sub>2</sub> : There is no difference between night rotating shift workers and day shift workers in terms of perceived level of drowsiness after a night with little sleep.	X	
H <sub>3</sub> : There is no difference between night rotating shift workers and day shift workers in terms of perceived ability to handle the loss of a night's sleep.		X
H <sub>4</sub> : There is no difference between night rotating shift workers and day shift workers in terms of trouble waking up in the "morning."	X	
H <sub>5</sub> : Night rotating shift workers will identify more frequent use of caffeine and tobacco products employed to stay alert during duty hours.		X
H <sub>6</sub> : Day shift workers will report more regular sleep than night shift workers.	X	
H <sub>7</sub> : Day shift workers will report more ease in falling asleep than night shift workers.		X
H <sub>8</sub> : Night rotating shift workers will report a higher frequency of restless sleep than day shift workers.	X	
H <sub>9</sub> : Day shift workers will express a higher degree of alertness during duty than night rotating shift workers.		X

Hypothesis	Accepted	Rejected
H <sub>10</sub> : Considering personal effectiveness to perform their security mission, personnel will approve more of the previous permanent shift than the current rotating shift.		x
H <sub>11</sub> : Considering all factors, personnel will approve more of the previous permanent shift than the current rotating shift.	x	
H <sub>12</sub> : Night shift workers will express the opinion that their family and friends dislike permanent shifts more than rotating shifts.	x	

#### D. Conclusions

The discussion section of Chapter 4 serves to distill several key points from the results contained in the preceding tables. Those key points were then presented as the major conclusions resulting from the survey of the 187 shift workers assigned to the 320th Security Police Squadron at Mather AFB, California. Those conclusions included:

1. Mather night and rotating shift workers reported significantly more work-related sleep problems than day shift workers even though both groups were similar in their nonduty-related sleep habits.
2. Possibly related to the above conclusion, the perceived level of job effectiveness was significantly lower in the night shift workers than the day shift workers.
3. The majority of these security policemen believed they had fewer accidents and disciplinary problems (i.e., were more

effective) while working a permanent as compared with a rotating shift schedule.

4. Many day shift workers reported that late night activities, including parties, interfered with their job effectiveness.

5. A significant number of night shift workers reported difficulty staying awake on the midnight shift.

6. This group of security police personnel clearly preferred to work a permanent shift schedule over a rotating shift schedule.

#### IMPLICATIONS FOR FUTURE RESEARCH

Practical research to identify and reduce negative effects of shift work on individual populations is relatively new. In fact, this study has virtually only scratched the surface in identifying the effects of shift work on the security policemen who perform it. Clearly, however, the results of this study support the need for additional investigation.

Since there is evidence that various subgroups of the security police population react to shift work differently, it is recommended that a larger study be accomplished which samples the entire population of security police personnel who are assigned to shift work duties. Future studies should collect demographic data to include (as a minimum): age, marital and parental status, type of residence, and length of shift work experience. With the additional demographic data, more accurate conclusions could be

developed about the influences of varying social goals and physical attributes.

Although the present study did not provide any data on the effects of chronotype ("morningness" or "eveningness") on individual adaptability to various shift work schedules, both the literature review and discussions conducted during the course of this study indicate there may well be merit in further study of this trait.

Another key area for future investigation is that of performance effectiveness. While this study contained data relative to self reported perceptions of effectiveness, it may be important in a critical career to develop tests of actual perceptual-motor effectiveness as influenced by various shift schedules. In addition to the analysis of the differences in effectiveness attributable to the influences of shift work schedules it may also be beneficial to compare real versus perceived effectiveness levels within each format. In what may be a related area, future studies might also benefit from an attempt to develop indicators of individual adaptation to the various shift work schedules employed by US Air Force units.

Finally, the data gathered in each of these areas must be evaluated by management experts. Their key objective, of course, is to identify the most appropriate shift schedules to produce maximum individual and collective job effectiveness and job satisfaction within the framework of manpower availability.

In conclusion, it is apparent that there are significant benefits to be gained from further study of the relationships between shift work schedules and those security police personnel who are assigned to work them. Security police duties involve the potential necessity for making split second life and death decisions which could well affect national security. Perhaps the present study will act as a stimulus to spur interest for initiation of additional research in this important area.

## Notes

<sup>1</sup> Simon Folkard, "Shiftwork and Performance," in The Twenty-four Hour Workday: Proceedings of a Symposium on Variations in Work-Sleep Schedules, eds. Lavern C. Johnson, and others, U.S. Dept. of Health and Human Services, National Institute for Occupational Safety and Health (Cincinnati, Ohio, 1980), pp. 347-8.

## Appendix A

## APPENDIX A

SHIFT SCHEDULE SURVEY

The survey you are about to help me with today relates to shift work. While the survey is voluntary, I urge your assistance. Your answers will have an impact on the shift schedules employed within the security police career field. When completing your answer sheets please do not fill in your name or other identifying data. Please use the number two pencil provided to you to fill in the circle on the answer sheet corresponding to your chosen answer for each question. You will not answer all questions. Read each question carefully and skip those which do not apply to you (leave the circles for those questions blank). My hope is that you will be totally honest in your answers so the surveys can be as accurate as possible. Again, thank you for your assistance in this important project.

1. Which shift are you presently working?
  - A. Flight, permanent days.
  - B. Flight, rotating swings and mids
  - C. Overhead staff, primarily days.
  
2. If you had a choice, would you choose:
  - A. Permanent shift
  - B. Rotating shift
  - C. Semi-permanent shift which rotates on schedule with local schools.
  
3. Considering only PERSONAL EFFECTIVENESS in terms of your job, if you were assigned to a permanent shift, would you choose:
  - A. Days
  - B. Swings
  - C. Mids
  
4. Overall, the schedule I most prefer to work is:
  - A. Permanent days
  - B. Permanent swings
  - C. Permanent mids
  - D. Rotating swings/mids
  - E. "permanent" shift rotating at college breaks
  - F. Other
  - G. No opinion

Please use the scale listed below to answer the following questions about your work schedule.

- A. I (they) like(d) it very much
- B. I (they) like(d) it more than I (they) dislike(d) it
- C. I (they) neither like(d) nor dislike(d) it
- D. I (they) dislike(d) it more than I (they) like(d) it
- E. I (they) dislike(d) it very much
- F. No opinion

5. Considering your PERSONAL EFFECTIVENESS to respond to security incidents, how do you feel about your previous permanent shift schedule?

6. Considering your PERSONAL EFFECTIVENESS to respond to security incidents, how do you feel about your current (permanent days with rotating swings/mids) shift schedule?

7. Considering ALL FACTORS (family, personal, social, job effectiveness, etc.), how did you feel about your previous permanent shift schedule?

8. Considering ALL FACTORS (family, personal, social, job effectiveness, etc.), how do you feel about your current (permanent days with rotating swings/mids) shift schedule?

9. How did your family, girlfriend or close friends feel about your previous shift schedule?

10. How do your family, girlfriend or close friends feel about your current shift schedule?

PERSONNEL CURRENTLY WORKING ROTATING SWINGS/MIDS ANSWER QUESTIONS  
11-25. ALL OTHERS LEAVE BLANK.

Please use the following responses for questions 11-19.

- A. Very strongly disagree
- B. Strongly disagree
- C. Disagree
- D. Neither agree nor disagree
- E. Agree
- F. Strongly agree
- G. Very strongly agree
- H. Not applicable, can't answer

11. After working several late nights in a row, I am able to "catch up" easily by getting one good night's sleep.
12. I find it easy to sleep during the day when I need to.
13. I am able to work at odd times of the day or night with little difficulty.
14. After a night with little sleep, I feel very drowsy the next day.
15. I am the kind of person who can easily miss out on a night's sleep without it bothering me.
16. I have trouble waking up in the morning.
17. I feel alert and effective in performing my security mission while working this shift schedule.
18. I often use caffeine or tobacco products to help me stay alert during duty hours.
19. When I work the midnight shift, I have trouble staying awake.

Personnel currently working rotating swings/mids, please select the most appropriate answer for questions 20-22.

20. During off-duty hours or days, how often do you use alcohol to help you readjust to a "normal" routine or schedule?
  - A. Never
  - B. Seldom
  - C. Occasionally
  - D. Often
  - E. Very often

21. How many hours of sleep do you typically get after working your current work schedule?

- A. 9 or more
- B. 8
- C. 7
- D. 6
- E. 5 or less
- F. Can't answer, not sure

22. How regular is your sleep after working your current schedule?

- A. Very regular -- I am able to get needed sleep every time
- B. Fairly regular -- I am usually able to get needed sleep
- C. Fairly irregular -- I am sometimes unable to get needed sleep
- D. Very irregular -- I am rarely able to get regular sleep
- E. Can't answer, not sure

Personnel currently working rotating swings/mids, please answer questions 23-25 using the most appropriate response below:

- A. Never
- B. Seldom
- C. Occasionally
- D. Often
- E. Very often

23. How often do you have trouble falling asleep after working this current schedule?

24. After working this schedule, how often is your sleep interrupted by periods of restlessness?

25. How frequently does noise at your housing interfere with your sleep?

PERSONNEL CURRENTLY WORKING PERMANENT DAYS PLEASE ANSWER QUESTIONS 26-34, OTHERS LEAVE BLANK.

Please use the following responses to answer questions 26-31.

- A. Very strongly disagree
- B. Strongly disagree
- C. Disagree
- D. Neither agree nor disagree
- E. Agree
- F. Strongly agree
- G. Very strongly agree
- H. Not applicable/ can't answer

26. After a night with little sleep, I feel very drowsy during the day.

27. I am the kind of person who can easily miss out on a night's sleep without it bothering me.

28. I have trouble waking up in the morning.

29. I feel alert and effective performing my security mission while working this shift.

30. I often use caffeine or tobacco products to help me stay alert during duty hours.

31. Late night activities and parties sometimes interfere with my effectiveness in performing my security mission while working this shift.

32. How many hours sleep do you typically get after working your current schedule?

- A. 9 or more
- B. 8
- C. 7
- D. 6
- E. 5 or less
- F. Can't answer/not sure

33. How regular is your sleep after working your current schedule?

- A. Very regular -- I am able to get needed sleep every time
- B. Fairly regular -- I am usually able to get needed sleep
- C. Fairly irregular -- I am sometimes able to get needed sleep
- D. Very irregular -- I am rarely able to get regular sleep
- E. Can't answer/not sure

34. How often do you have trouble falling asleep working this current schedule?

- A. Never
- B. Seldom
- C. Occasionally
- D. Often
- E. Very often

35. After working this schedule, how often is your sleep interrupted by periods of restlessness?

- A. Never
- B. Seldom
- C. Occasionally
- D. Often
- E. Very often

ALL PERSONNEL, PLEASE CONTINUE ON NEXT PAGE

ALL PERSONNEL, please answer the remaining questions.

36. We seem to have fewer accidents involving flight personnel when working:

- A. Permanent shifts
- B. Rotating shifts

37. We seem to have fewer disciplinary problems on flight when working:

- A. Permanent shifts
- B. Rotating shifts

Please select the most appropriate response for questions 38-40.

- A. Rotating swings/mids
- B. Permanent days
- C. Permanent swings
- D. Permanent mids
- E. "Permanent" shift which rotates in accordance with local college/university schedule
- F. Rotating days/swing/mids
- G. Other
- H. No opinion

38. Now that I've thought about it more, I think the best shift for me to work in terms of my EFFECTIVENESS to perform security police duties is:

39. Now that I've thought about it more, I think the best shift for me to work in terms of my FAMILY/SOCIAL life is:

40. Overall, to do my best work and still maintain a good family/social life, the best shift schedule for me is:

41. Which flight are you currently assigned to?

- A. A Flight
- B. B Flight
- C. C Flight
- D. D Flight
- E. Not assigned to flight

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